INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

IPCC WGII
Fourth Assessment Report
Climate Change Impacts, Adaptation and Vulnerability

Expert Review of First Order Draft

Specific Comments

Chapter 3

December 5, 2005

Discussion of expert review comments and record keeping

IT IS RECOMMENDED THAT:

- AUTHORS BEGIN WORK ON THE COMMENTS IMMEDIATELY. SUBSTANTIVE COMMENTS NEED TO BE SEPARATED FROM NON-SUBSTANTIVE, AND THE TWO SHOULD BE TREATED DIFFERENTLY
- CONTACT IS MADE BETWEEN AUTHORS AND THEIR REVIEW EDITORS IN DECEMBER

Substantive comments

- The chapter writing team should discuss all substantive expert review comments, by email and/or at Merida.
- Substantive comments require full and proper consideration. The *Principles Governing IPCC Work* state that:
  - genuine controversies should be reflected adequately in the text of the Report and
  - it is the role of the Review Editors to advise the lead authors on how to handle contentious/controversial issues
- You must record the outcome of these discussions in this document, under the column 'Notes of the Writing Team'.

Non-substantive comments

- For non-substantive comments, a very brief entry should be made in the column 'Notes of the Writing Team'. The following terms are acceptable:
  - Addressed
  - Not applicable
  - Text removed
  - A tick to denote a comment has been addressed (somewhere on the document this should be stated)

General

- The record can be kept electronically, or with pen-and-paper.
- The document becomes part of the traceable account of the Working Group II Fourth Assessment. When completed to the satisfaction of the Review Editors, a copy should be returned to the TSU by the **28th February 2006**.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-0	A	0				**Co-chair and TSU comments**	
						There are few Contributing Authors. These provide an opportunity to spread the author base.	Done
						Length:must be reduced from current 70 pages of A4 Word to 45 pp maximum, i.e. by at least a third. This reduction must be achieved in SoD.	Done
						Authors must force themselves to consider what are a) the truly important and new knowledge, and b) what are their implications (eg for costs, socio-economic aspects, sustainable development); and condense their assessment to its essentials.	Yes
						English needs polishing throughout. Maybe identify a new contributing author for this task?	Point taken
						Section 3.4 now exists in first draft, which is good. But it needs considerable condensation; and the later sections eg on costs, adaptation, concusions/sustainability are not K45yet adequately assessed.	Substantial improvement made. Not quite sure what K45 is.
						The Conclusions are missing. The title of S 3.7 should be:" Conclusions: Implications for Sustainable Development"	Yes
						The Excutive Summary and Conclusions omit mention of some key areas: a) what is new knowledge regarding impacts under different socio-economic pathways (eg SRES); and b) under differerent mitigation scenarios; and c) under different amounts of adaptation.	Very limited literature available

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						The current ES seems different from TAR only in respect of (new) observed effects. Is this the case: that there are no other significant new areas of knowledge?	Significant revision made
						Omit italicised sections in SoD. (but I agree that they are useful in FoD)	Done
						S 3.2 current sensitivity. This whole section is a thorough and valuable assessment. I suggest two things a) you should now liaise closely with ch1, and b) this section should be condensed to its essentials (maybe much reference material and summary conclusions could be in a table?) and reduced to HALF its current length.	Whole S 3.2 removed (condensed material passed on to Chapter 1 for possible use)
						For example, in S 3.4.1 Table 3.2 is an excellent summary of new publications (but could this table also include one-line summaries of the main conclusions regarding effects on river flows?)	
						S 3.4.1 is now a solid assessment of new knowledge on impacts. The maps are useful. But please think of ways of being more concise: a) one way is to report the conclusion and the source (eg "It is now evident that ….[ref]" rather than " so and so in a study of such and such a place found that...." Readers do not need to know the detail of the latter; and they can find it out in your ref, especially with the new regional database; and b) use tables to summarise conclusions, references, and places studied.	Considerable revision following the spirit of the comment
						S 3.5 is very thin: suggest you bring sections on water availability and shortage to here; and bring demand here; and cover effects under different devt pathways here (i.e. SRES); and also assess the costs K52literature more thoroughly.	Improved (K52?)
						S 3.6 is also very thin, though it covers several pages. This all needs condensing to, I suggest, a maximum of 5 pages (that is reducing by half in length, while containing much more condensed information). Reduce the boxes substantially. Again: why not summarise	Improved

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						adaptation practices/options in a table? S 3.7 should be titled "Conclusions: Implications for sustainable development". It is completely missing any discussions of conclusions: especially: a) what is new info about effects under SRES; b) under mitigation ; and c) under differing adaptation? S 3.7 should include a matrix of available knowledge of projected effects under different assumptions about the future I recommend the authors consider following the example of ch 4 in creating an effective summary of findings, thus: a) a table summarising impacts by increments of T change (table 4.5) b) a summary map of projected impacts, worldwide (fig 4.9) c) a burning embers diagram for each FFF type to show key vulnerabilities (fig 4.10) This is a copy of comments on the ZERO-ORDER DRAFT of Ch3 Water by Martin Parry in Jan 2006 [with added observation in square brackets regarding what response is made in FOD]: General comments: This chapter is less complete than others, and thus quite difficult to comment on.1). It is not clear what the main emerging conclusions are regarding the new knowledge since 2000 TAR. 2) Throughout, the emphasis should be on the new knowledge, laid on the basis of what was reported in TAR. 3) Statements should be supported by reference to published material (much is not). 4) The new knowledge that should be reported probably includes new published assessments regarding; a) impacts under stabilisation scenarios; b) impacts under SRES futures; c) new regional studies, especially in developing countries, including results from the AIACC project. These are currently missing. Quite a lot of space is taken up with intriductory material that does not seem essential, and could be summaries quite briefly. The main next step seems to requre a	Substantial revision made SOD is a considerably improved draft, with MP comments reflected

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						thorough reading and assessment of the new literature so that the writing team can draw some emerging conclusions about the new knowledge. [FOD has written up assessment of current effects and projected impacts; but has yet to assess: costs/socio-economic; adaptation; and conclusions/sustainability] Sections needing reduction to allow space for additional material elsewhere: Reduce sections 3.1 and 3.2 [3.1 has been reduced; 3.2 still needs reduction to half] Areas missing: 1) analysis of thresholds/key impacts. 2) Assessment of effects on demand [key impacts are now in draft FOD but needs substantial condensing, which means prioritising what you want to say] Reduce 3.1.1 currently 2 pages, to one short intro para. Omit Fig 1 since this can be stated in a sentence. [done] good Reduce this section 3.1.4 currently to (say) 2 sentences, omitting diagrams. These systems were understood and reported in the TAR: only a reminder is necessary here. This should leave you substantial space to expand section 4, which is needed [done] Table 1: Might this not be better in concluding section, drawing all eassessment together? By placing it here, and without references, makes it not clear if this table summarises your assessment of impacts, or of curent sensitivity, or hypothesises connections which wil later be examined. Each statement should be substantiated by ref to sources. [done] Section 3.2 omits to assess current adaptation [still thin, but not a priority] Suggest you summarise (and shorten text) by using numerical tables to report the assumpions of pop/income/tech under various SRES futures. [interesting new info now included, but conclusion not clear about effects under different pathways and these do not feature in Exec Summary points]	

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						From page 20 onwards Section 3.4 needs more substance and more pages. Could not some of the key conclusions in TAR be re-assessed and updated eg 1) a new Table 4.1 in TAR updated to 2000-2005? 2) New versions of Fig 4.1 in TAR showing new data on effects under a) stabilisation and b) SRES futures? c) New table 4.8 from TAR showing new regional studies publishes since TAR? Section 3.4 is missing assessment of effects on demand [might be better in 3.5] Section on costs deserves considerable expansion [still needed] Section 6 on adaptation warrants expanding, especially with ref to the new literature [needs substantially condensing] Table 3: How much of this was not reported already in TAR, and could better be summarised in a few lines? [well, it is still here; but I do not see what it says specifically about water; could apply to response in any sector] **(Martin Parry)**	Draft dramatically reduced
						Though incomplete this FOD version of Chapter 3 is too much extensive (assigned 30 pages). Many of the examples included should be coordinated with the respectives chapters particulary regarding regional references. This action may reduce extension. Although about 100 million people is already afected by natural insidious contamination, mainly with Arsenic and Fluoride; however, no reference is made of this hazard. Information is basic for decision making because of the many health problems and live losses resulting from the consumption of the underground water with high Ar or F concentrations (Ref. The Atlas of Water, R. Clarke and J. King, Earthscan, 2004). This is an important reference due to increasing underground water mining, definitely influence by the Earth ´s warming. In spite of the fact that wars have been initiated due to water	The authors are not aware of any recent wars due to water shortage, yet the danger of potential is there.

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						shortages (Africa, Middle East, Latin America) no reference is made to this critical social and economic situation. Missing references. For instance in page 7 four reference brackets need to be completed. In all places where mentioned, the water issue shall be refered as a target and not as a goal of the Millennium Development Goals (it is target 10 in MDG 7) In spite of the fact that guidance notes suggest to consider the consecuences of water managment on WEHAB sectors, the potential effects are missing. **(Osvaldo Canziani)**	
3-1	A	0				Inconsistency in usage of different units in the given and other chapters: e.g. /year ; yr**-1 ; /a some uniformity SI system where applicable would be necessary (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	SI system followed
3-2	A	0				GENERAL COMMENTS: There is a wealth of information in this draft chapter, touching on most aspects of climatic effects on Freshwater Resources. The authors are to be commended for doing, on the whole, a comprehensive job of assessing relevant information, and providing a good balance among the different regions of the globe. The "core" section of the chapter (3.4. Key future impacts and vulnerabilities) follows a logical narrative and generally examines impacts within the desired time slices (2030s, 2050s and 2080s), though this is not always possible. A few gaps in the coverage have been identified in my detailed comments and specific additional literature has been suggested. There are a few sections that still need to be written, as already pointed out in the draft. "Added value" is often, though not always, evident. Because of the wide scope of the chapter, there is a tendency to enumerate facts and findings. The implications of such information are much easier to assimilate where the authors have provided concise tables and critical summaries. I have not checked accuracy and completeness of citations, but identified occasional discrepancies that I happened to notice. Grammatical and linguistic aspects were ignored. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Comment taken onboard
3-3	A	0				There are several spots in the chapter where the writing is quite uneven. I assume that this will be resolved as further editting occurs. There are also several spots	YES

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						where the level of detail is quite different between the various sections. I will highlight some of these issues in the comments that follow. The issue of attribution of changes only appears in the research priorities, and then only as a "placeholder". I agree that this is a key issue that has not yet been adequately resolved. However, there has been some work exploring this issue, which should be referenced in the chapter, at least as a point of departure for future work. Two examples are: Burn, D.H., O.I. Abdul Aziz and A. Pietroniro (2004). "A comparison of trends in hydrological variables for two watersheds in the Mackenzie River Basin", Canadian Water Resources Journal, 29(4), 283-298 and Burn, D.H., J.M. Cunderlik and A. Pietroniro (2004). "Hydrological trends and variability in the Liard River basin", Hydrological Sciences Journal, 49(1), 53-67. (Donald Burn, University of Waterloo)	
3-4	A	0				There is heavy reliance for many key points in this chapter on work by Oki and other authors of the Chapter 3. At times this makes the chapter seem a bit inbred. (Rob de Loë, University of Guelph)	Oki's domination reduced dramatically
3-5	A	0				Finally, the nature of this review process is such that most of my comments appear as criticisms. I'd like to conclude my feedback with a positive thanks to the writing team for taking on this enormous and onerous task. It's important work, and, I fully understand, very hard to do. (Rob de Loë, University of Guelph)	No action needed
3-6	A	0				"Governance" is an important but ambiguous term. It's used in places in the chapter without proper definition or contextualization. (Rob de Loë, University of Guelph)	Revised
3-7	A	0				Chapter 3: An impressive review. In the introduction the major findings of TAR and insufficiently tackled issues of TAR are listed. After reading the FOD I got the impression that the major findings and untackled issues are still the same after this new assessment. I suppose that section 3.8 will give a synthesis of the review and the question: what new insights have we gained over the last 5 years? (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	There have been no dramatic, break-through type developments.
3-8	A	0				Freshwater resources and their management are of concern globally. However, each region should be considered specifically, eg. problems related to droughts, floods and future impacts may be more serious in Asia or coastal areas than other regions. Unfortunately, these issues have been only slightly mentioned in chapter specifically dedicated to the region, eg. Chapter 10 for Asia. (Savitri Garivait, The Joint Graduate School of Energy and Environment (JGSEE))	No action needed
3-9	A	0				Many cited papers do not appear in the reference list; please cross-check thoroughly.	We have devoted substantial amount of work to this issue

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						(Dieter Gerten, Potsdam Institute for Climate Impact Research)	
3-10	A	0				Citations not provided within comments. Most are available from my home page at http://members.cox.net/igoklany/. I'll also be happy to send hard copies, if requested: [1]. Goklany, IM. 2000. "Potential Consequences of Increasing Atmospheric CO2 Concentration Compared to Other Environmental Problems." Technology 7S: 189-213. [2]. Goklany, IM. 2002. "Comparing 20th Century Trends in U.S. and Global Agricultural Land and Water Use." Water International 27: 321-329. [3]. Goklany, IM. 2005. "A Climate Policy for the Short and Medium Term: Stabilization or Adaptation?" Energy & Environment 16: 667-680. [4]. Goklany, IM. 2005b. "Integrated Strategies to Reduce Vulnerability and Advance Adaptation, Mitigation, and Sustainable Development," accepted by Mitigation and Adaptation Strategies for Global Change. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Ignored
3-11	A	0				Clearly too long! I found much of the text to be rambling without clear conclusions or summaries. Many statements were repeated, both between sections and within the same section. This work resembles more a 0 order than a 1st order draft. As much of the text is not mature enough for detailed comments, most of my comments will be of a general nature. Everything should be made more concise and to the point; there is much imbalance between the different sub-sections as some co-authors have been permitted to write extensively on some subjects. Other sections are incomplete and some are even empty. I was disturbed by the number of occurences where "references needed" was stated. This gives me the impression that in some instances conclusions were made first, to be supported by appropriate references. I strongly remind the co-authors that they should strive to review all available literature first and then draw their conclusions. Many cited references were not included in the reference list. After noting some 20 such occurences I didn't continue to keep track. This has inhibited the review process. References to Europé, Canada, Russia and USA seem to dominate (although I haven't made a quantitative assessment of this). All co-authors should try to be more comprehensive where possible. If relevant studies and literature are lacking for specific regions or sectors, this should be highlighted. These highlighted regions and sectors should be included in the discussion of needed future research, which will presumably be made in section 3.7. No harmonization has been made on confidence levels. Some co-authors include	Revised accordingly

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						such statements as "[high confidence]" while others do not. Personally I find such statements highly subjective and wonder if there are any common guidelines as to how they are made. My suggestion would be to leave them out, with the exception of possibly including them in a short list of robust conclusions (in the executive summary perhaps?). I do not understand the function of the boxes. They are never referred to in the text. An exception is on page 22 (ln47), where reference is made to a box that presumeably does not exist (or at least I do not see a connection between the statement made there and any of the three boxes). Not all figures are referenced; dor they all come from the literature or are some specifically produced here. Include appropriate references in all figure captions. There are several occurrences where reference is made to "growing" temperatures or temperature "growth". I think in the context of this chapter, this must refer to "rising" temperatures. There are repeated instances where the word "significant" is used in the text. For many people this word has a statitistical implication. I suggest going through the text and checking each of these occurrences. To avoid mis-communication, replace all non-statistical uses with a different, but similar, word. I think the co-authors often mean things like "considerable" or "outstanding" when they use this word. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	
3-12	A	0				The chapter discussions would be enhanced if model outputs from the three SRES scenarios that were run for the WGI report discussions (i.e., A1B, B1, and A2) were presented side-by-side for each (or at least, several) of the major impact discussion topics. The current discussion in the chapter seems to be limited to the A2 and B2 scenarios, and, in most cases only considers the ECHAM model, rather than the full suite of 11 models (or their ensemble) outputs from the WGI discussions in the global modeling chapter. Collaboration with the authors of WGI chapter 11 (regional climate modeling -- including dynamic models and statistical downscaling models) should also be encouraged when preparing the next draft of this chapter, as there as been much interaction between the climate modeling and water management community on basin-specific studies already in this field, some of which is discussed in the IPCC WG1 Chapter 11 already. (Chuck Hakkarinen, retired (2002) from Electric Power Research Institute)	Chapter has been modified and many of this comments have been revised accordingly.
3-13	A	0				I would give greater emphasis to adaptive management of water resources with increased monitoring of hydrologic and weather conditions. Effective adaptive management will often require changes in the legal and institutional frameworks since water system operating rules may need to be changed quickly. In high	Elements of this comment taken onboard

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						mountain areas such as the Rocky Mountains of North America, the likely reductions of snowpack (that constitutes a huge natural reservoir) and earlier runoff imply the need for increased reservoir and/or groundwater storage to maintain currents rates of water supply. The effects of an earlier and longer cropping season on water demand remain uncertain. (Charles Howe, University of Colorado-Boulder)	
3-14	A	0				I like to complement the authors for accomplishing successfully their difficult review task. However, there are several issues whose resolution would improve the quality of Chapter 3: 1) In Appendix 2 of the Guidance Notes for Expert Reviewers it is noted that the maximum recommended length for Chapter 3 is 30 pages. However, in its present form, just the text of Chapter 3 is 69 pages. One possible area for reducing page numbers would be to reduce the figure sizes, and doubling or trebling the related figures within one page with a single figure caption. If the page limit is absolute, then another course of action would be to halve the material in each of the subsections.There are also some repetitive material that I shall detail in the specific comments below. 2) A very important issue is the credibility of the presented results. However, except Figure 3.2, no other comparisons between the model simulations of the historical hydrological conditions versus their observed counterparts is provided. Meanwhile, the guidelines for the important subsection "3.4 Key future impacts and vulnerabilities" state that "...confidence levels (for the inferences) should be specified whenever possible." One way of quantifying such confidence levels would be by means of comparisons between the discrepancy magnitudes from observations of the modeled historical hydrologic simulations versus the modeled change magnitudes in the corresponding hydrologic variable under future climate change. In the IPCC Third Assessment 2001 report a whole chapter (Chapter 8. Model Evaluation) was devoted to this issue of the suitability of AOGCMs for use in climate change projection. (Levent Kavvas, University of California, Davis)	Revisions have been made reflecting these comments
3-15	A	0				Drought in Bulgaria, A Contemporary Analog for Climate Change (2004; eds. C. G. Knight, I. Raev, M. P. Staneva), Aldershot, UK: Ashgate) may be useful to the authors as an example of using a contemporary period of drought to suggest concerns about plausible future climate impacts, especially on water. The chapter should note somewhere that some global assessments of water sufficiency make the error of attributing the entire flow of international rivers to multiple countries in the basin. Thus countries like Bulgaria are noted as having sufficient water as if the Danube could be depleted by Bulgaria without other consequences. There is no simple answer to this accounting dilemma, but observing	A very local (specific) assessment

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						that Bulgaria politically and practically could not meet its demands from the Danube moves it from rich in water to among the most highly vulnerable in Europe. (C. Gregory Knight, Pennsylvania State University)	
3-16	A	0				No mention of use of grey water, or is this not relevant? (Geoffrey Levermore, Manchester University)	Ignored
3-17	A	0				The opening statement in Chapter 3 states, The Executive Summary presents seven key emerging findings regarding freshwater resources in relation to current and future sensitivities, trends, impacts of, vulnerability and adaptation to climate changes as well as implication for sustainable development. The reader logically assumes, therefore, that the subsequent "key emerging findings" are succinct inferential statements derived from the detailed material contained in sections 3.2 to 3.8. Unfortunately, this assumption is wrong for at least several of the findings. For example, the second key finding states Floods and droughts have become more severe in some regions are very likely to increase in severity still further. Curiously, however, it is difficult to infer this finding from a careful reading of the reports cited in Section 3.2.5 on Floods, droughts and their impacts. Summary Observation: Providing an accurate and meaningful perspective on observed hydroclimatic conditions and variations is absolutely vital to being able to ascertain if and when the world has entered a new climate state where our historical statistics are no longer applicable. We haven't reached that point yet, and the text of this chapter should not be "implying" that we have. There is simply no need to try to demonstrate in every section of this chapter that conditions have deteriorated in a manner consistent with human-induced climate change theory. In most cases, THEY HAVE NOT. They have, however, continued to vary in a fashion consistent with historical experience. Has it never occurred to anyone that the theory, at least in part, may be wrong? Perhaps the hypothesized "enhanced hydrologic cycle" is, indeed, manifesting itself with increasing precipitation and streamflow, but that it is doing so in a relatively benign manner. Is this so novel and unacceptable a possibility? If not, then why isn't it being posited in this report? Certainly, it's what the observed data appear to be telling us. I believe the IPCC and the world community would be better served if the report used the observational record to test the theory (the traditional pattern in science) rather than torturing the data into conforming to the theory. Science will ultimately pay a bitter price if the IPCC continues to subvert long-held and well-tested practices. References Cited Hurst, H.E., Long term storage capacities of reservoirs, Trans. ASCE, 116, 776-808, 1951. Cohn, T.A. and Lins, H.F., Nature's style: naturally trendy, Geophys. Res. Lett., in press.	Very strong criticism. Partially, deserved. Care was taken to rectify the situation.

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						(Harry F Lins, World Climate Programme-Water)	
3-18	A	0				General Remarks: The draft presented provides an enormous amount of detailed results on the subject of “Climate Change and Water Supply”. For this reason it is sure to be a valuable resource for decision-makers in Water Resource Management. Nevertheless, we would like to propose several improvements based on our years of experience in this field: 1. From the perspective of someone working in the field of Water Resources Management, this topic is not given the attention it deserves in Chapter 3. While reading the outline for this chapter, we already noticed that this topic is dealt with only in subchapters (e.g. 3.2.9 & 3.6.1). At these locations, moreover, the discussion is invariably superficial (especially in 3.2.9). A systematic discussion of the wide variety of existing structures (e.g. state-run, private, public-private partnerships, etc.) would have been very useful here since these are vulnerable to the changed climatic conditions to different degrees. Furthermore, the texts included in the individual chapters were written by different authors and are, as a result, very inhomogeneous. 2. The chapters should be given more structure and this structure should extend through all the subchapters. Subchapter 3.4.6 (Water availability and use) could serve as a model here: - different climatological regions · semi-arid and arid · humid - different scales · global scale · national scale · basin scale - different development stages · developed countries · developing countries - different climate scenarios 3. All important statements should be summarized and evaluated at the end of the chapter as has already been done in Subchapters 3.4.4 and 3.5: - high - medium confidence - low A summary in table form provided at the end of each chapter would possible made	Revised

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						the existing deficits more obvious. Otherways, it is very difficult for the reader to evaluate the results since they are presented in part as summaries of a large number of individual studies. 4. The literature cited frequently reflects the countries of origins of the Lead Authors and is thus not always representative or comprehensive. A better balance is needed here. Attention is called to this deficit in the individual chapters. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	
3-19	A	0				General comment concerning the freshwater sections of Chapers 3 and 4. There is an emerging literature on experimental studies concerning the effects of warming on the processes within freshwater systems that the authors have not covered. This literature gives definitive information on likely warming effects that the sort of descriptive and correlative studies mostly quoted cannot. The relevant references are: McKee, D., D. Atkinson, S. E. Collings, J. W. Eaton, A.B. Gill, I. Harvey, K. Hatton, T. Heyes, D. Wilson, and B. Moss. 2003. Response of freshwater microcosm communities to nutrients, fish, and elevated temperature during winter and summer. Limnol. Oceanogr. 48: 707-722. McKEE, D., HATTON,K., EATON,J., ATKINSON,D, ATHERTON,A, HARVEY, I., & MOSS, B. (2002) Effects of simulated climate warming on macrophytes in freshwater microcosm communities. Aquatic Botany 74, 71-83. McKEE, D., ATKINSON,D., COLLINGS, S., EATON,J., HARVEY,I., HEYES,T., HATTON,K., WILSON,D. & MOSS, B. (2002) Macro-zooplankter resonses to simulated climate warming in experimental freshwater microcosms. Freshwater Biology, 47, 1557-1570. Moss, B., McKee, D., Atkinson, D., Collings, S.E., Eaton, J.W., Gill, A.B., Harvey, I., Hatton, K., Heyes, T. & Wilson, D. (2003) How important is climate? Effects of warming, nutrient addition and fish on phytoplankton in shallow lake microcosms. J. Applied Ecol. 40, 782-792. The gist of the findings are that warming per se will have only small effects on ecosystem processes in complex freshwater systems that have many biological buffers to their stability, but that some important effects are detectable, including an increased release of phosphate from sediments, that may exacerbate the symptoms of eutrophication (already a serious problem). The other finding of general significance was that from a community of plants included in the experiment, an introduced warm-water plant, Lagarosiphon major, native to South Africa, came to dominate. As exotic species are a major problem everywhere now, this has	This is more pertinent to Chapter 4

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						particular implications. Also , you might mention the possibilities of introduced, damaging fish like the common carp, Cyprinus carpio, which currently does not breed successfully in the UK and northern Europe because it is slightly too cold, being able to breed and spreading rapidly. Carp are very destructive fish that have destroyed conservation value in many shallow lakes (CARVALHO, L. and MOSS, B. (1995) The current status of a sample of English Sites of Special Scientific Interest subject to eutrophication. Aquatic Conservation: Marine and Freshwater Ecosystems 5,191-204.). (Brian Moss, School of Biological Sciences, University of Liverpool)	
3-20	A	0				Chapter of very unequal quality (clarity, examples) and scientific integrety. It is clear the authors had a mission, to say that climate change is a threat and already hapenning - The (nearly only) publication references mentionned are on those lines, omitting too often the uncertainty surrounding the field, either in terms of evidence, or in terms of signal. Misleading text can be found in the trends section (there is a lot more evidence of NO trends than on trends), on runoff projected changes (problem of scale not mentionned, difference in GCMs projections only limited) to quote only few. It is extremely important NOT to draw conclusions not yet observed, and only build the document from supported evidence, otherwise, climate-change sceptic will take advantage. There is an urgent need for many major revisions to be made, that would add scientific integrety to the report. At the moment, the document feels almost as an 'intellectual fraud'. This document will be a world reference, used by politicians, environmentalists and scientists alike. It is the duty of the authors to have it right, and to produce a document of very high standard. This standard at present is very far from what it must achieve for this chapter, and major revisions are compulsory before it could reach such a standard. When likelyhood statements are made e.g. [High confidence][Medium confidence], must be supported by references. At present, is not. A lot of tidying-up for references, quite a few not published. The organisation of the chapter could be improved: seems to have a repetition of concepts talked about (i.e. trends on river flows) in section 3.2.1 and 3.2.5: can't they be merged together? Or be much more distinct from each other? Also, what is the overlap with Chapter 1 (not reviewed)= needs to be careful not to have too much repetition, but here only to present facts if more exhautive examples are provided in chapter 1. There are a lot of examples extremely regional/ specific (e.g. in the prairies; in Yorkshire ,very small region of the UK) = would recommand to delete them as they only provide anecdotal evidence, but no significant foundings. I understand the document aims to provide a general picture, not local examples. Results would need to be significant at the	Intelectual Fraud—that is too much!!! However, these comments have been carefully considered in order to improve SOD. Rapid warming has been much shorter!

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						regional level (region = big, subcontinent). It must also be stressed that trends are only significant if assessed on a LONG (> 50years) record, and that natural variability of the climate may suggest trends on a 20-30 years period, which disappear looking at the longer picture of 50-100 year. Extreme care is needed when interpreting trend results of short records. Finally, some of the section on evidence present actually some modelling results - Need to be careful not to mix observational evidence with modelling results. (Christel Prudhomme, Centre for Ecology and Hydrology)	
3-21	A	0				Acknowledging the early stage of the draft the chapter is still disappointing. The text does not flow and some text does not relate to the section in which appears. There is no flow to the chapter and sense of a story being told, which I suspect reflects the multi-author nature of the writing,a nd is somethig that will be develop through subsequent drafts. (Nick Reynard, Centre for Ecology and Hydrology)	Chapter has been changed a great deal.
3-22	A	0				This chapter is well written and clearly presents the implications of climate change relative to water resources. Several sections are just complete and very agreable to read. Its structure follows the outline suggested for AR4 in the appendix and there is no doubt that the authors added value to the literature review. It is surprising however to note that the chapter is no complete and that several parts of the text and tables need more references or a refreshed list of references. Keep in mind that the evelautaion can only be completed when the chapter is presented in its integrity. In general, the chapter does not cover the problem of modified agricultural practices relative to climate change (CC). In addition, the authors do not discuss the contamination potential by nitrates in their chapter which is crucial within the water quality problems. This is a problem that is particularly prominent in rural areas with intense agricultural activities. Even if the authors mention that N concentration can build up in surface and ground waters of agricultural areas, they do not refer to the threat on human health caused by nitrate concentrations in water above recommendation thresholds (10 mg/L N-NO3 in most courntries). Although this is not discussed clearly in most of the literature there is a risk that CC will impact the nitrate loads in many areas where the growing season will be longer due to a rise in temperature. There are possibilities for more spreading of chemical fertilizers and for more nitrates in waters by consequence. This is forecasted by 3 scenarios out of 4 (p.26, L20-26), adaptation treatments such as deeper drilling of wells (with isolated upper length) and installation of nitrate filtering systems should be	At least someone liked our FOD Agrigulture sits in another Chapter

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						discussed as well in the adequate chapter sections (e.g. p. 26, L33-34). (Martin Savard, Geological Survey of Canada)	
3-23	A	0				I have not checked the reference list against text citation systematically, only those that I was interested in (many are missing, see comments). I have noted many spelling and punctuation mistakes but I do not report them here as indicated in the review guidance. (Martin Savard, Geological Survey of Canada)	Authors tried to correct these deficiencies as much as possible
3-24	A	0				General comments on a whole chapter: In general the chapter shows in the 3.2, 3.2 and 3.4 a heterogeneous picture of the present knowledge mixed with assumptions about climate change impacts on hydrology. Fortunately the existing uncertainties and ways to characterize them (e.g. by ensembles of model result) are described. Other model-based studies which do not consider the still existing limitations of our knowledge are in a strong contrast and should be removed or at least expressed more careful to avoid conflicts with other statements given in the same chapter. In the Fourth Assessment Report the limitations of extreme simplified mono-causal approaches to the complex theme of climate charge which were typical for the First and Second Report should be avoided (Examples: increasing temperature = increase in evapotranspiration, higher amount of precipitation is equivalent to increased flood risk etc.). In the comments some of the contradictions caused by different views of the authors are pointed. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Comment carefully considered
3-25	A	0				I commend the Authors of this chapter (Chapter 3) for under taking this difficult task. My comments are intended to be of general nature at this point and I hope they will be of some value to the authors. I will fist comment on the my impression of the current state of the chapter followed by my own personal views about the general nature of placing water resources in the context of climate change and the IPCC effort. Impression of the current state of the chapter At this stage, the chapter reads as a collection of contributions by different authors. This is expected for a first draft but much needs to be done to streamline the chapter and eliminate redundancies. I like the adaptation section. Some General thoughts In my view, given the variability of observed trends in the components of the hydrologic cycle are so highly regional in nature, it is extremely challenging, if not	Comment carefully considered

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						impossible, to draw too many universal conclusions outside the regional context. Many of these reported studies on ground water, erosion, or water quality, show trends and are linked with climate variations influencing the forcing and/or input to these systems, as expected. The challenge in the context of an IPCC report will be; can one make any kind of statement about the climate link and can one separate the observed variability and trends which are natural, from the ones that are supposedly because of the observed "climate change" as measured due to increases in global temperature? I appreciate the long list of references on ground water and water quality links to climate. However, these systems are highly impacted by human intervention and therefore, one should be very careful of the interpretations of the results in the climate change context. It is also surprising that there is little coverage of the hydrologic links to climate phenomena such as El Nino, where some links to drought and above normal precipitation trends have been established. In my view, the last section on research priorities is perhaps the most important and it is yet to be added. It is this section that the point has to be made that long term impact of climate change on freshwater resources has to be examined in a regional context and hence a framework need to be developed. (Soroosh Sorooshian, University of California-Irvine)	
3-26	A	0				Since I am an economist and not a specialist in water resources, I have nothing in particular to say about most of this chapter's content. Indeed, the authors' description and analysis of recent hydrological trends seem thorough and convincing, as do their projections of future trends. This review focuses on economics and policy – areas not adequately addressed by the chapter. The authors of this chapter present a compelling case that global climate change will reduce the availability of fresh water during the twenty-first century, precisely as the demand for this resource is growing. However, they neglect the role that prices and markets can and should play in dealing with rising scarcity – certainly in the irrigation sector and with respect to other water uses as well. Unless this omission is corrected, this chapter is unlikely to have the impact on public policy that the authors desire, I am sure. (Douglas Southgate, Ohio State University)	Economics and policy addressed more thoroughfully in the SOD.
3-27	A	0				On the whole, no major objections. I really concentrated on the drought issue (and those sections referencing drought) since this is my background and where my expertise is.	Another positive remark.

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						(Mark Svoboda, National Drought Mitigation Center)	
3-28	A	0				By and large, this chapter is in a good shape. It would be good to have a bit less enumeration and a bit more synthesis. Also, the chapter emphasizes the natural/engineering side at the expense of the social side. There are wonderful political science studies on adaptation (Bakker, Cohen, Miller, Werff). (Richard S.J. Tol, Uni. Hamburg)	Thank you, Richard. We tried to strengthen the weaker side in SOD.
3-29	A	0				Other general Comments: 1) I note that none of the Lead Authors have English as a native language, and it shows. The whole document needs a substantial clean up and edit in the English. 2) Similarly, no North American or Australian LAs seems to lead to lack of knowledge about relevant literature that ought to be referenced. 3) Several sections deal with findings that are the role of WG I. This is a problem because the findings often conflict with WG I. Several examples follow: P 4 L 45 to p 5 l 12: this is more WG I L 45: bullet 1 is meaningless. L 1: bullet 1 is questionable: how, why? Bullet 2 is incorrect as it depends on mitigation: the risk of floods may increase but whether they do or not can be addressed by planning and mitigation. P7: l 9-p8 l 42. As noted on line 9 this requires coordination with WG I. P 7 L 15-17 is wrong, see WG I, and especially Trenberth et al 2005: Trenberth, K. E., J. Fasullo, and L. Smith, 2005: Trends and variability in column-integrated water vapor. Clim. Dyn., 24, 741-758. L19-20. There is no evidence of recent increases in land precipitation. Nor is there good reason to expect this given effects of aerosols that short circuit the hydrological cycle. No where in this chapter is the effects of aerosols addressed. L 23-25: This needs revision. See WG I. Extremes are expected: see also Trenberth et al 2003. L 18 is wrong, see Wg I. The growth of waaater vapor does not affect precipitation amount, the former is the storage and the laatter is the rate of throughput. What increased water vapor does is increase the precipitation rate. See especiallly Trenberth et al, 2003. Trenberth, K. E., A. Dai, R. M. Rasmussen and D. B. Parsons, 2003: The changing	Some comments are well taken and have been considered and addressed. The bullets are from Chapter 4 (WG2-TAR) by Arnell et al, 2001.

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						character of precipitation. Bull. Amer. Meteor. Soc., 84, 1205-1217. P 6: L 49: This is wrong, it is not at all like SST. What are references? Suggest you see Dai et al., 2004: Dai, A., K. E. Trenberth and T. Qian, 2004: A global data set of Palmer Drought Severity Index for 1870-2002: Relationship with soil moisture and effects of surface warming. J. Hydrometeor., 5, 1117-1130. P 9 L 2: Not sure this is right, see Dai et al 2004. P 10 l 1-13:This is wrong see Chapter 3 WG I for sections on dimming and surface heat balance. L 27-28: This is dealt with by WG I chapter 4. P 11: all to p 12 L 23: This is mostly not appropriate here as it is done more completely in WG I chapter 4. What is here is fragmentary and incomplete, and sometimes wrong. For instance, the surface heat budget is what matters for glacier ablation, not just air temperature rise and changes in precipitation. So cloudiness, radiation, water vapor, pollution (dirty ice) etc all play important roles. P 37: 3.4.3: See Chapter 4 of WG I. (Kevin Trenberth, National Center for Atmospheric Research)	
3-30	A	0				However there are some things that are becoming well established and robust, mostly not adequately recognized by this chapter, and it would be excellent if the chapter could simply try to deal with a few of these issues and make recommendations. In particular, the literature is dated with regard to changes expected; please see chapter 3 of WG I for an updated assessment of climate changes to date. The robust changes expected in precipitation are for increases in intensity, even in cases with reduced amount, increased risk of heavy rains and floods, and also drought. Please see Trenberth et al. (2003), for instance. Thus 100 year rains become more like 30 year events as time goes on. Also warming means more rain, less snow, more melting and earlier spring runoff: a very robust finding regardless of changes in amount. Surely the main challenge is for water managers to deal with times of excesses of water, when they don't need it and time of deficits in water when they do. Typically the excesses come in winter or spring and the	Material on observations has been removed and forwarded to Chapter 1

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						need is greatest in summer. Focusing on these robust things and making recommendations for adaptation and planning would seem worthwhile. (Kevin Trenberth, National Center for Atmospheric Research)	
3-31	A	0				Please note that, in addition to my day job, I am also a CLA of Chapter 3 of WG1 for AR4. Chapter 3 deals with observations at the surface and in the atmosphere and also plays a role in synthesizing other observations on oceans and the cryosphere. Consequently, we cover an enormous amount of ground that is directly relevant to this (and other) WGII chapters. A major concern is that a lot of the material in this chapter is somewhat at odds with our own findings and summary, the literature cited in this chapter is not as current and a lot is missing. In our chapter, after a lot of culling, we have a full 26 pages of citations at single spaced font. My general comments on this chapter are that is very fragmentary, it does not hang together well, it needs a major edit in terms of the English, and it does not seem to pull all the pieces together well. It does not do an assessment. The material covered seems to reflect that directly known to the lead authors and does not adequately cover a lot of other literature from other countries, such as the United States or Australia. There are redundancies among sections, most notably the 3.2 and 3.4 sections and it might be a major space saver to combine these. (Kevin Trenberth, National Center for Atmospheric Research)	We have shifted most of material on observations to Chapter 1
3-32	A	0				This chapter fails to make assessments throughout the document; instead it reviews or summarizes some of the literature, but without assessing its value or utility. It, and a lot of the literature, make use of model scenarios but without assessing the models and their utility. In 3.8 it notes that models are not reliable and so why cite their results? In fact we know that no model does the hydrological cycle well (when one examines amount, frequency, intensity, duration, and type of precipitation: all models tend to have too much precipitation at too low frequency and premature onset of convection and rain (as judged by the diurnal cycle, for instance)). This means that no model-based scenario is fully credible and all studies must be assessed as to their value and relevance. This is not done. Many of the studies cited use models, their results are model dependent, and no assessment is made. Typically there is no synthesis of all the studies cited. At present there are no summaries or recommendations (as to the effectiveness of various possible options) in any subsections. (Kevin Trenberth, National Center for Atmospheric Research)	Authors have tried to do more assessment in SOD
3-33	A	0				The term “climate change” is used a great deal (e.g., p 19 and many other spots)	More care given to the wording

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						without saying what climate change under what scenario, or in what variable over what time frame and whether it really is a change or a variation.. Climate change as projected varies from region to region and with time of year. Sometimes it is used to mean "projections" but then if does not deal with the range of projections and possible outcomes, especially for precipitation. Often the document assumes certain climate change that is almost certainly wrong. Or it considers some possibilities but not others. In some places scenarios are treated as predictions. It should then say "risk" not "will".The result is very vague and meaningless statements. (Kevin Trenberth, National Center for Atmospheric Research)	
3-34	A	0				The last section is 3.8 and it deals with uncertainties and research priorities supposedly (it doesn't really). Shouldn't there be a recommendations section or commentary on options? For instance: · Recognize that climate change is with us and the past is no longer a good guide for the future. · Status quo is not an option. · There is a need to build in climate change into planning on all time scales (not just long time scales) · Increase resilience and recognize the likelihood of greater extremes · Adopt management measures that are robust to uncertainty · Recognize the multiple stressors, not just climate change · Improve conservation, storage, drainage, ground cover, dams, reservoirs, levees, and management tools. · Reduce waste. · Invoke adaptive management · Warn about inflexible or conflicting policies and point out that if people won't adapt, then nature will do it for them (autonomous adaptation: witness New Orleans and Katrina) (Kevin Trenberth, National Center for Atmospheric Research)	We have a new section 3.8
3-35	A	0				Another major concern is that this chapter does not deal with other facets of climate change adequately that are the domain of WG II. A good example is floods. A major component of floods is 1) heavy rains. But there are many other factors than enter into floods, including 2) the presence of snow, 3) the condition of streams, rivers, ice dams, and lake levels; 4) the ground cover, infiltration, vegetation, deforestation; 5) soil wetness, 6) topography, slope, drainage, etc; and perhaps most important 7) human structures and mitigation devices, including dams, levees,	Comment reflected

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						reservoirs, culverts, drainage channels etc. In fact the continual attempts by various bodies, most notably government bodies such as the Corp of Engineers in the US, the Bureau of Land Management, local governments and city councils, etc to build structures to improve drainage and mitigate floods is often so large as to overwhelm other effects: until they fail as has happened in the case of hurricane Katrina, for instance. There is a major failure to recognize these aspects and deal with them. (Kevin Trenberth, National Center for Atmospheric Research)	
3-36	A	0				Despite the fact that several chapters are not yet complete, the text is about three times longer (90p) than it should be, so in the comments in the Excel file, I will, as requested, try to point out larger parts that can be left out. Here I will focus on the more important fact that the text is not very strong yet. It is, rather, a collection of lists, facts, heuristics, speculations, and personal research findings. In terms of content, there seems to be a constant mixing of effects of direct human interventions in the hydrological cycle (such as floods caused by river canalizations) and climate induced effects. My apologies for being somewhat harsh but given the good reputations of the authors, it should be possible to improve this extremely important chapter, especially because there is still ample time until the final draft. The story that needs to be told is complicated, much more complicated than the story of rising temperature. It is, therefore, paramount that a consistent story-line is followed throughout the different sub-chapters. Not every conclusion is equally strong or supported by measurements. More emphasis should be given to proven facts and softer conclusions should be left out. Perhaps a clear line is: 6. The proven temperature rise affects the hydrological cycle directly and indirectly. 7. Direct effects are relatively clear and predictable: 7.1. Retreat of glaciers 7.2. Higher snow lines with associated shifts in snowmelt runoff regimes to rainfall runoff regimes 7.3. ... 8. Temperature rise comes with general climate change, which has indirect effects on the hydrological cycle. Clausius-Clapeyron tells us that with every 1 degree increase in temperature, the water holding capacity of air increases with 7%. We, therefore, have to assume there will be a quickening of the hydrological cycle. These changes are difficult to detect because: 8.1. Impacts will differ between regions, some regions will be drier, others wetter, some will become more extreme. This makes detection of an overall global trend	Most of the comments have been considered through different sections

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						impossible. 8.2. Impacts of changes in the hydrological cycle are mainly felt through increases in extremes (floods, droughts). In contrast to changes in the mean, changes in these higher moments of the underlying probability distribution can statistically only be proven with very long time series, which are not available. 8.3. The impacts are compounded by direct human interventions in the hydrological cycle. Canalization of rivers may increase flooding, degradation of land may increase (the impact of) droughts, etc. This makes it difficult to filter out only the climate induced changes. 9. Present GCM's perform very poorly when it comes to the hydrological cycle. The best we can do at the moment is weighted multi-model ensemble mean (WEM). WEM results do indeed confirm general trends (quickening of hydrological cycle) but the underlying variance is too large for reliable predictions. Given that negative hydrological impacts are regional and caused by shifts in extremes, resources should be allocated to improve the performance of (regional) climate models with respect to water. 10. The combination of almost certain changes in the hydrological cycle with almost complete uncertainty with respect to sign and magnitude of these changes at regional level, cause the most important and very observable impact, namely that extra uncertainty is injected in decision making concerning water resources management. The costs related to this extra uncertainty are already enormous... All material for this, or an even clearer story-line, is clearly there (except for the promised literature that proves more extremes). The main point may be point five, which is already well presented but is a bit snowed under by all the other statements. In any case, at present no clear line of reasoning can be discerned and direct/indirect, certain/speculative, climate/other changes, are all mixed, which makes for very unsatisfactory and unconvincing reading. Defining one line that would be maintained throughout would be better. It should also make it easy to stay within the thirty pages, while ensuring this chapter will have an impact. Despite the fact that water quality was made part of the overall structure of Chapter 3, the climate change effects on quality (including erosion) tend to be derivatives of derivatives, which makes the analysis particularly speculative. Given the need to shorten the text, I would strongly suggest to reduce the quality/erosion related sub-chapters to (next to) zero. What is further a bit tiresome to read is that it is suggested that every change in climate will cause extreme havoc, dry places will become drier, wet places will become wetter, etc. This is not very subtle and quickly undercuts the story's credibility.	

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						(Nick van de Giesen, Delft University of Technology)	
3-37	A	0				The chapter will require further effort to unify the style of commentary which ranges from fairly general in earlier sections to highly detailed in latter parts. The section on "Atmospheric and surface waters" (3.2.1) should be backed by more citations and should also cover lakes, wetlands, estuaries and lagoons. The term "evaporation" should be applied more rigorously throughout to discriminate between potential and actual evaporation. Similarly, the debate about CO2 fertilisation versus water efficiency should be handled consistently - some parts highlight the large uncertainty in the resulting water balance (e.g., p36); others make statements of fact (e.g., p13, p45). The issue of combined climate change mitigation and adaptation is barely addressed (apart from a few lines on p68). The chapter does not really tackle this issue of climate change attribution and water resources (as promised on p5). More attention could be paid to changes in the joint probability of extremes (e.g., riverine flood and tidal surge, or saturated soils and intense rainfall). (Robert Wilby, Environment Agency of England and Wales)	Points have been taken
3-38	A	1	1	91	17	GENERAL COMMENTS: It is obvious that this is an incomplete version of the Chapter 3. There are numerous mistakes and editorial problems that prolonged this review extensively. Since this review should be based on the literature search the most complications came from the reference list - a lot of documents are not listed and they appear in the text; quotations in the text do not match the titles or/and authors in the list; many references are only for information (there is no chance that user can get the access to them) and therefore their use is questionable; many references are not published yet. Some of these problems will be addressed in detailed comments that follow. Key general comments are: (a) document provides a good review of the current state of knowledge but do not present the findings in an organized way that they can be easily accessed by the reader; (b) many findings are incomplete (only for particular regions) without any indication why are these regions selected and others are not; (c) I would suggest a serious improvement of the presentation of main global information - all graphs should be of high quality, well explained in the text, clearly pointing out the source, and any contradictory information addressed (for example presentation of the graph that shows quite different results for different climate models); (d) all main information should be also condensed into tables to accompany the graphs (it is highly unlikely that the readers will read the whole document in order to use some of the information from it); (e) document is providing some contradictory information (in one location	Some points have been taken

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						irrigation demand is predicted to be higher and in the other to be lower); (f) this document should include some discussion of the virtual water (regional transfer of water through goods that are being exported or imported); (g) document should also find some space to address the changes that are arising from sale of the bottling water and the influence of this on ability of communities to invest into water supply infrastructure that has to meet the challenges of climatic change and variability; (h) sections on integrated water management and sustainable water development must be improved – text is very weak in spite of the fact that there is a lot of sources that provide useful information; (i) adaptation through management should be improved too – an organized presentation of supply management and demand management must be presented in the light of current technologies and tools available to water resources managers; (j) this document failed to address on of the main issues related to urban drainage and flood control – what is the state of knowledge related to change of design standards for urban drainage infrastructure and flood protection structural measures in the light of climatic change; (k) document is also missing to address the role of storage (reservoirs) as instruments to mitigate climatic change impacts; (l) urban and rural water supply is not given adequate attention in the document; and (m) choice of case studies is not clear and not very informative. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	
3-39	A	1	1	91	17	The main comments concern the complete chapter, which do not fit this prescribed format very well. For easier reading, a separate RTF file with the same text is attached (Chapter3_FOD_NvdG.rtf, click on this cell in case this file is not available). Despite the fact that several chapters are not yet complete, the text is about three times longer (90p) than it should be, so in the comments in the Excel file, I will, as requested, try to point out larger parts that can be left out. Here I will focus on the more important fact that the text is not very strong yet. It is, rather, a collection of lists, facts, heuristics, speculations, and personal research findings. In terms of content, there seems to be a constant mixing of effects of direct human interventions in the hydrological cycle (such as floods caused by river canalizations) and climate induced effects. My apologies for being somewhat harsh but given the good reputations of the authors, it should be possible to improve this extremely important chapter, especially because there is still ample time until the final draft. The story that needs to be told is complicated, much more complicated than the story of rising temperature. It is, therefore, paramount that a consistent story-line is	Some points have been taken into account.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						followed throughout the different sub-chapters. Not every conclusion is equally strong or supported by measurements. More emphasis should be given to proven facts and softer conclusions should be left out. Perhaps a clear line is: 1. The proven temperature rise affects the hydrological cycle directly and indirectly. 2. Direct effects are relatively clear and predictable: 2.1. Retreat of glaciers 2.2. Higher snow lines with associated shifts in snowmelt runoff regimes to rainfall runoff regimes 2.3. ... 3. Temperature rise comes with general climate change, which has indirect effects on the hydrological cycle. Clausius-Clapeyron tells us that with every 1 degree increase in temperature, the water holding capacity of air increases with 7%. We, therefore, have to assume there will be a quickening of the hydrological cycle. These changes are difficult to detect because: 3.1. Impacts will differ between regions, some regions will be drier, others wetter, some will become more extreme. This makes detection of an overall global trend impossible. 3.2. Impacts of changes in the hydrological cycle are mainly felt through increases in extremes (floods, droughts). In contrast to changes in the mean, changes in these higher moments of the underlying probability distribution can statistically only be proven with very long time series, which are not available. 3.3. The impacts are compounded by direct human interventions in the hydrological cycle. Canalization of rivers may increase flooding, degradation of land may increase (the impact of) droughts, etc. This makes it difficult to filter out only the climate induced changes. 4. Present GCM's perform very poorly when it comes to the hydrological cycle. The best we can do at the moment is weighted multi-model ensemble mean (WEM). WEM results do indeed confirm general trends (quickening of hydrological cycle) but the underlying variance is too large for reliable predictions. Given that negative hydrological impacts are regional and caused by shifts in extremes, resources should be allocated to improve the performance of (regional) climate models with respect to water. 5. The combination of almost certain changes in the hydrological cycle with almost complete uncertainty with respect to sign and magnitude of these changes at regional level, cause the most important and very observable impact, namely that extra uncertainty is injected in decision making concerning water resources	

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						management. The costs related to this extra uncertainty are already enormous... All material for this, or an even clearer story-line, is clearly there (except for the promised literature that proves more extremes). The main point may be point five, which is already well presented but is a bit snowed under by all the other statements. In any case, at present no clear line of reasoning can be discerned and direct/indirect, certain/speculative, climate/other changes, are all mixed, which makes for very unsatisfactory and unconvincing reading. Defining one line that would be maintained throughout would be better. It should also make it easy to stay within the thirty pages, while ensuring this chapter will have an impact. Despite the fact that water quality was made part of the overall structure of Chapter 3, the climate change effects on quality (including erosion) tend to be derivatives of derivatives, which makes the analysis particularly speculative. Given the need to shorten the text, I would strongly suggest to reduce the quality/erosion related sub-chapters to (next to) zero. What is further a bit tiresome to read is that it is suggested that every change in climate will cause extreme havoc: dry places will become drier, wet places will become wetter, etc. This is not very subtle and quickly undercuts the story's credibility. (Nick van de Giesen, Delft University of Technology)	
3-40	A	2	0			List of acronyms would be very useful. I would suggest defining: TAR, SRES, WGI, JJA, LSM, WEPP, GCM, ENSO, NAO/AO, WEM, AGCM, WGHM, IS92 and all other that I missed. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	The acronysm will be defined in FAR
3-41	A	3	0			Comment on Executive Summary. As noted in the comments immediately following this one, some of the statements do not give the full flavor of discussion around the topic. Also, there is no indication was to whether -- or to what extent -- current changes are within the bounds of natural variability. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Difficult issue. See Cohn & Lins – Nature's style – Naturally trendy (GRL, 2005)
3-42	A	3	0			Comment on Executive Summary. The summary has a few significant gaps: [1] Given the importance of soil moisture, there should be a couple of sentences addressing this matter. For this, I recommend noting the results of Robock et al. (2000) [noted on p. 9, lines 1 to 4] which are based on empirical data, while also noting that these trends do not track general expectations in a warming world. [2] It should be noted that for reasons not understood and contrary to general expectations, pan evaporation has declined in the latter half of the 20th century (see p. 9, line 30 to p. 10, line 1).	The ES has been revised.

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						(Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-43	A	3	0			Executive summary - Needs a lot of work and re-wording. At present, it NOT supported by evidence. Again, this is extremely important to get the executive summary right, as it is probably the only page that will be read by all (only few readers will actually read the details of the chapter). At least the two first key facts are misleading/wrong (see comments in section 3.2.1). There is no mention of the large uncertainty surrounding climate change projections (e.g. see p68,l46-50: must be in executive summary) (Christel Prudhomme, Centre for Ecology and Hydrology)	New ES
3-44	A	3	0	4		Using 7 key findings as the basis for the Executive Summary is good, and I agree with the thrust of numbers 3, 5, 6 and 7. Number 4 I am not best-placed to comment on. Numbers 1 and 2, however, on river flows, floods and droughts I feel has fallen into sound-bites and media-type assertions. The "take-home" message for policy makers (lines 14 and 15) is both dangerous and unsupported by the body of observed evidence. It doesn't reflect the more cautious, but still in my view misleading, statements in the following sentences or the balance of the scientific argument presented within chapter 3.2.5 itself. Compare: 'Floods and droughts have become more severe in some regions and are very likely to increase in severity still further.' (Page 3, line 14) With: 'Summarising, no general and consistent change is visible in observational records – globally, no uniform increasing trend in flood flows has been detected.' (Page 16, line 9) It is true that in some regions 'statistically significant changes of high river flow' have been detected (some suggesting increases, other decreases). But that does not make them compelling trends in circumstances when there is such clear sensitivity to the timeframe over which the analysis is made. Globally, the work of Kunderwicz et al (2005) is the most comprehensive analysis; no strong evidence for increases in amax was found. In the UK, Alice Robson and Duncan Reed also found no compelling long term trend and work completed using the UK Benchmark network (currently being written up) supports this conclusion. Specific reference is made to England having 'changes of high river flow detected from long term gauge records are already statistically significant' (line 18). This is presumptive (note the 'already' in headline 1, which should really be changed to 'always'?) and disingenuous. The context implies that the changes are positive when in fact there is no compelling long term trend in amax (for example). The issue of whether the frequency of high flows is increasing whilst major flood generating flows are not is an interesting one which merits addressing in the body	New ES

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						of the report (it is too subtle for the ES). (Nick Reynard, Centre for Ecology and Hydrology)	
3-45	A	3	0			DETAILED COMMENTS: Executive summary: All needs revision in light of other comments..It seems like the items 1 and 2 are primarily WG I. "stronger" 8-10 is not the right word. Item 3 l 25: Why is water demand likely to grow due to climate change? L 37-41: this material does not follow. (Kevin Trenberth, National Center for Atmospheric Research)	Considerable revision made
3-46	A	3	1	4	15	Start with finding line 48 (Quantitative projections…) (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	?
3-47	A	3	1	4	15	It is noted that further editing is required. (Klaus Radunsky, Umweltbundesamt GmbH)	Yes
3-48	A	3	1	91	17	The English throughout needs to be reviewed by a native speaker, not just to improve the grammar but also because the present choice of words at times confuses. For example, in the all important executive summary, it says "precipitation […] will continue to change towards more intense and intermittent spells." Is that good or bad? What are "more intermittent spells"? (Nick van de Giesen, Delft University of Technology)	Some editing needed.
3-49	A	3	3	4	15	to add confidence level for these statements (Chunzhen Liu, Water Information Center,MWR)	Difficult
3-50	A	3	7	3	10	Two almost identical senteces are repeated (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Done
3-51	A	3	7	3	23	These lines include statements which are very strong and thus have to be supported by clear observations in peer-reviewed journals. It must also be clear whether the conclusions concerning observed changes refer to man made global warming or just climate variability (see below comments on page 7). (Sten Bergström, Swedish Meteorological and Hydrological Institute)	Not only peer-reviewed journals. Also grey literature allowed. Yet, we admit – attribution is a problem.
3-52	A	3	7			Are we really able to differentiate between changes and variabilities? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Differentiate or atribute? Point taken
3-53	A	3	9			I propose to add "water quality" (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Revised
3-54	A	3	10	3	12	The Executive Summary states: Very strong winter climate-related runoff increase (typically between 50 and 70% within the last two decades) has been detected in most pristine Russian rivers." However, Pg. 8, lines 25-31 gives different figures	New ES

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						for increase in runoff for rivers in Russia, Belarus and Ukraine, most of which I doubt are pristine. What is the basis for the Executive Summary statement? That section concludes (Pg 8, lines 39-42) that because of human interventions "it is very difficult to evaluate how much change in river discharge can be attributed ot the climate change." This conclusion is correct, but the uncertainty it conveys is not reflected in the Executive Summary. (Lenny Bernstein, IPIECA)	
3-55	A	3	10	3	12	This conclusion also applies to parts of the Canadian north (see, for example, the two references from above). (Donald Burn, University of Waterloo)	
3-56	A	3	10	3	12	Same increase observed in southern Finland rivers during the last 15 years.Hyvvärinen; V. 2003. Trends and Charateristics of Hydrological Time Series in Finland. Nordic Hydrology, 34(1/2),2003,71-90 (Bertel Vehviläinen, Finnish Environment Institute)	Reference noted
3-57	A	3	11		12	in the exec.summary we should not only mention just one region. It would make more sense to characterize the climatological conditions under which this strong increase in runoff is happening (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	ES Revised
3-58	A	3	14	3	23	The Executive Summary concludes that the floods and droughts that have become more serious in some regions are very likely to increase in severity still further. The only regions identified are England and continental Europe, a very small portion of the globe. A better definition is needed of what portions of the globe are already affected and whether these portions of the globe are expected to expand. Also, the statement about floods has to be balanced by the conclusion on Pg. 16, lines 9-10: "...globally, no uniform increasing trend in flood flows has been detected." While floods are increasing in some areas of the world, they are decreasing in others. The conclusion that drought are likely to become more serious in the future appears to be based on the climate model studies discussed on Pg 24-25. That discussion begins with an accurate description of the limitations of climate models in predicting future precipitation trends. The Executive Summayr needs to reflect those limitations in our ability to forecast future precipitation levels. (Lenny Bernstein, IPIECA)	New ES.
3-59	A	3	14			Comment on para. While literally correct, it would be just as accurate to say "Floods and droughts have become less severe in some regions and are very likely to decrease in severity further." Accordingly, I would recommend a more even-handed characterization, namely: ""Floods and droughts have become less severe in some regions and more severe in others. They may or may not be exacerbated in	New ES

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						the future." (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-60	A	3	14			What is the exact mechanism/causal relationship between (man-made) global warming and the change in precipitation characteristics? (Hans H.J. Labohm, Netherlands Institute of International Relations 'Clingendael')	Out of scope in Chapter 3
3-61	A	3	14			What means "severe"? Is it seen for the background of the hydrological conditions or in relationship to socio-economic effects? Please specify it ! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Socio-economic context
3-62	A	3	14	3	24	I suggest that this general conclusion be more carefuly worded to take into consideration of regional differences potential impact of climatic change on floods and droughts. Regions that are going to experince change should be identified and direction of change should be clear - increase, decrease (with adequate level of confidence). (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	
3-63	A	3	14	3	23	a)In Finnish Lapland new 3 records of max discharge at 1992 and 2004 in spring floods induced by snowmelt. Caused by record snow storage and winter snow precipitation. Warming was not enough to melt the water.b)On the other hand 1992 we did have nearly record dry year with household water shortage at southern and central c)Finland.At 2004 there was a record summer flow at Vantaanjoki river.No references for this new data.d) Wrmer and wetter winters tend to decraese flooding by ice jams (less ice mass in the river) but enhance farizil ice flooding duet to the facts that rivers are more ice free and prone to farzil ice flooding during cold spells. This kind od situation wsa at Kokemänjoki rivet at the city of Pori. (Bertel Vehviläinen, Finnish Environment Institute)	Observation material removed now.
3-64	A	3	20	3	21	the statement "floods caused by snowmelt and ice-jamming show a downwards trend in some areas", which appears in the Executive Summary, is nowhere substantiated in the main body of the report. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	ES Revised
3-65	A	3	25			Comment on para. Water demand, may or may not grow, depending a variety of factors, including crops selected for cultivation, agronomic practices. (See also p. 51). (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Revised
3-66	A	3	25	3	30	While the authors acknowledge that these conclusions are made based on limited data, but even then and as expected, the observed trends are regional with some up, some down and some no significant changes.	Revised

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						(Soroosh Sorooshian, University of California-Irvine)	
3-67	A	3	25			I am not sure if the conclusion on water demand and climate change (pg. 3 line 25) can be generalized beyond the regional context. (Soroosh Sorooshian, University of California-Irvine)	
3-68	A	3	26			Water demand depends on a number of variables (population, socio-economic status, ecosystems, etc), therefore text should be added between “level” and "due"; so to read “global level also due to climate change.” (Osvaldo Canziani, IPCC)	Section revised
3-69	A	3	29			Add "environmental" conflicts (Robert Wilby, Environment Agency of England and Wales)	Section revised
3-70	A	3	32	3	40	This paragraph should refer to natural insidious contamination (Ar, F, etc) (Osvaldo Canziani, IPCC)	Section revised
3-71	A	3	32			I am not certain that the general conclusion (line 32 on page 3) on the connection of climate change and water quality, in the context of IPCC, can be supported based on the arguments given. (Soroosh Sorooshian, University of California-Irvine)	Section revised
3-72	A	3	32	3	41	Warm wet winters increase the inflow to lakes and Baltic sea. At the same time nutrient load increases considerably due to increased discharge (increased transfer capacity) and due to higher errosion and diffuse nutrien load from the land. Bilaletdin, Ä., Kallio, K., Frisk, T., Vehviläinen, B., Huttunen, M. & Roos, J. 1994. Modelling the effects of climate change and phosphorus transport from a drainage basin. The Finnish Research Programme on Climate Change. Second Progress Report.SILMU. Publications of the Academy of Finland 1/94. Painatuskeskus.Helsinki. pp.128-133. (Bertel Vehviläinen, Finnish Environment Institute)	Section revised
3-73	A	3	33	3	34	Speaking of speculative, the third key emerging finding may take top prize: Climate change impacts on water quality are likely to be serious. This is an interesting “finding,” more so because very little is actually known about the relationship between climate and water quality beyond the need to adjust constituent concentration based on discharge magnitude. To my knowledge, no one has ever demonstrated a consistent set of rules or systematic relationships governing water quality response to hydro-climatic variations. That’s probably because the mix of processes and environments produces a universe of potential outcomes so complex that it defies simple analytical characterization. Accordingly, hyperbolical statements such as adverse effects of growing severity of water extremes on water quality have been well established, and where water flows decrease, water quality is exacerbated (p. 3, lines 33-34), misrepresent the degree to	Interesting comments Related sections have been revised. Many points taken into new SOD

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						which science understands these complex relationships. For one thing, as demonstrated earlier, there have been no systematic changes in hydrologic extreme events, so how can it be that the effects of their growing severity on water quality have been well established? The simple answer is, they haven't been. As for the effect of low flows on water quality, it is important to recognize that few events are completely good or completely bad. In this instance, most low flows commonly occur during the warm season. Thus, while it may be true that higher water temperatures accompany extended periods of lower flows, with attendant effects on fish populations, it is also true that low/drought flows also increase water clarity which, in turn, promotes benthic vegetation growth and enhanced fish/shellfish habitat, particularly in estuaries. So there is nothing clear-cut about this subject, yet the current text implies that it is and that it's nothing but bad news. Both the wording of the "finding" and the text in the section on water quality (Section 3.2.5) grossly oversimplify the complexity inherent in this issue. Balance matters, and this "finding" is a clear example of where no balance exists. I do not believe that there is, as yet, enough known about climate and water quality in the past and present climate to make anything more than idle speculation of what may attend a future climate. Land use, agricultural, and public policies all exert far more influence on variations and changes in water quality than do climate. Thus, I urge the removal of this item as a "key emerging finding" from the Executive Summary. I appreciate that these comments challenge the inveterate practice in IPCC reports of writing executive summaries that tend to make a case for governmental action as opposed to simply summarizing and making inferences from a collection of "facts." However, this practice has always decoupled the document that non-scientists (as well as some scientists) read from the factual contents of associated technical chapters and the scientific literature itself. At some point, the decoupling becomes so complete that the two documents become contradictory. I believe that the items I commented on above fit into this category. These three "key emerging findings" so misstate what is actually (and factually) known as to undermine the efficacy of the entire chapter. This is not a matter of "interpretation," or a disagreement over the degree to which something is true or not. Rather, these three "key findings" statements are either wrong or grossly misrepresent what has actually been documented. Either way, they are unacceptable transmogrifications of the current state-of-knowledge in hydro-climatic science. (Harry F Lins, World Climate Programme-Water)	
3-74	A	3	39			Sea water intrusion also affects fresh water supplies from estuaries therefore line 39 should read as follows: "intrusion in estuaries and coastal aquifers.	Revised

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						Groundwatersaltation will be exacerbed by over pumping..." (Osvaldo Canziani, IPCC)	
3-75	A	3	39			Leave over-pumping out (not climate related). (Nick van de Giesen, Delft University of Technology)	But adds to climate change impacts
3-76	A	3	43	3	46	This finding should be the first in the list of Chapter findings. As detailed in the chapter's introduction, and in many other studies, the world faces severe problems of water availability and quality even without climate change. The number of deaths each year attributable to poor water quality dwarfs the number of deaths due to floods or drought. The areas of the world currently suffering severe water stress are discussed on Pg. 18, lines 24-32. This information should be summarized in the Executive Summary. Climate change is a serious threat, but it is not the only threat the world faces. IPCC authors need to keep that in mind. (Lenny Bernstein, IPIECA)	Revised
3-77	A	3	43	3	46	This paragraph might be linked or, probably, merged with one in lines 25 to 30 (Osvaldo Canziani, IPCC)	Revised
3-78	A	3	43	3	46	I think that in this paragraph you should note that one of the most important anthropogenic factors is surface and ground water diversion for irrigated agriculture that in some areas is greatly reducing stream flow for example (Jiongxin 2005). Further, you might note that the impoundment of water in large reservoirs for hydropower, agriculture, recreation is also increasing evaporative loss and reducing stream flow. Jiongxin, X. 2005. The water fluxes of the Yellow River to the sea in the past 50 Years, in response to climate change and human activities. Environ. Manage. 35:620 - 631. (Thomas Huntington, U.S. Geological Survey)	Observations-relevant material removed
3-79	A	3	46			The last sentence should be changed as follows: "Climate change may or may not exacerbate the situation". That would seem to be a more accurate statement of what may (or may not) happen in the future. See, for example, Table 3.3 which indicates that population living in water stressed areas will decline due to climate change (in 2050). (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Ignored.
3-80	A	3	48			Strike "quantitative". See p. 42, lines 32-34. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-81	A	3	48			If precipitation is not reliably simulated in climate models, then are not all of the various studies cited throughout this chapter suspect?? (C. Gregory Knight, Pennsylvania State University)	State-of-the art

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3-82	A	3		27		Although the text in lines 3-27 attempts to give a little lip-service to the role of growth in population, wealth, and development, it dismisses these factors with the unsupportable statement that these factors alone cannot explain the observed growth of the damage and a part of losses is linked to climatic factors (lines 7-8). This is an inordinately certain statement for something that no one has ever documented. The truth is, increased population, wealth, and development CAN very easily explain the observed growth in damages. These three factors traditionally have been, and continue to be the accepted explanation. In reality, major destructive floods are truly rare events. So rare, in fact, that even if one occurs that is the worst recorded in the last 175 years (page 15, line 11), then on a statistical basis the event could not be separated from the "expectation" that such as event was "overdue." If three such floods had occurred on the Vltava River in Prague over the past 20 years then, perhaps, the climate change argument might have a little more veracity. The long-understood and well-documented nature of flood hydrology is that record-breaking floods occur in every decade at some locations around the globe -- they always have, and always will. It is disingenuous, at best, to try to give the impression that the continuation of this long established pattern is due to climate change in the locations described. Doesn't anyone think it a little surprising to expect that a 0.6 degree C warming over the past 100 years, something that is completely imperceptible to anything other than a modern digital thermometer, would be the cause of flood disasters that were worse in 1990-1998 than in the previous three-and-a half decades (page 15, lines 4-5)? This claim doesn't pass the smirk test. I recommend that this entire section be rewritten to provide a clear and unequivocal perspective on the fact that extreme events are not increasing, and that the rise in flood loses is caused by the continuing increase in development in flood-prone areas, and the rise in drought vulnerability and loses is caused by the increasing movement of people into areas known to be historically drought-prone. (Harry F Lins, World Climate Programme-Water)	More careful wording used in SOD
3-83	A	4	0	5		The next version of introduction needs to do a better job of identifying the really critical issues for the water sector. (Rob de Loë, University of Guelph)	Critical issues are now covered in SOD
3-84	A	4	3			Meaning unclear "water-related consequences of climate policies.." (Robert Wilby, Environment Agency of England and Wales)	
3-85	A	4	5	4	6	Instead of "Whereas it is difficult to make concreate projections;" please, consider a sentence like "Even with a high degree of uncertainty, it is expected that hydrological characteristics will change in the future".	Obvious

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Constanta-Emilia Boroneant, National Meteorological Administration)	
3-86	A	4	5	4	15	Water course management: Lake and reservoir regulation has to adapt to the changed sea-sonal runoff. Central lakes of catchments as Saimaa, Päijänne and Näsijärvi have frequent winter floods due to wet and warm winters. Frequent winter floods call for free storage ca-pacity in reservoirs at winter and less storage capacity for spring in southern Finland. In northern Finland storage capacity is still needed for snowmelt floods. For longer and dry summers reservoirs should be filled up in spring in southern Finland. Better operative use of regulated reservoirs, more accurate and frequent observations and forecasts and even recon-struction of dam outlets are needed. Roughly estimated more than half of the 220 regulation permissions need adjustment. Cost depends whether the adjustment needs to be processed through public announcement or not. Experiences thus far have shown that with lighter public announcement process takes 3-5 years. (FINADAPT working papers.Adapting to climate change: current knowledge, future needs Final Seminar, Finnish Environment Institute (SYKE): 14-15 December 2005); Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095 (Bertel Vehviläinen, Finnish Environment Institute)	
3-87	A	4	7	4	7	I think the sentence: "Therefore in water management, the past can no longer be the key to the future" is not a conclusion of the previous sentences. Please, reformulate or remove it. (Constanta-Emilia Boroneant, National Meteorological Administration)	Revised
3-88	A	4	7	4	7	better: ... the past can not longer be the key to the future alone (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	Revised
3-89	A	4	9	4	9	Instead of "consider adaptation options" I think more appropriate could be "consider adaptation requirements". (Constanta-Emilia Boroneant, National Meteorological Administration)	disagree
3-90	A	4	9	4	9	better: ... take into account climate change too and ... (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	
3-91	A	4	10	4	10	in the German states / countries Bavaria and Baden-Wuerttemberg too (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	
3-92	A	4	16	4	17	I suggest that one more conclusion be added addressing the need for adaptation that will be possible only through appropriate combination of structural (reservoirs, dikes, water supply and drainage systems, etc.) and nonstructural adaptation measures (design criteria for dikes, design criteria for drainage networks, etc.). (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	New Section 3.6 in SOD

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3-93	A	4	24	4	25	Instead of "Climatic system and freshwater system are interconnected in a complex way" plaese, consired a sentence like: "Freshwater system as one of the components of the climate system is interconnected in a complex way with the others, so that any change in one of these components induces a change in the others." (Constanta-Emilia Boroneant, National Meteorological Administration)	No comment
3-94	A	4	24			What means "freshwater system"? As water (fresh and salt water) belongs to the climatic system the difference is not clear. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	No comment
3-95	A	4	27			instead of (e.g., runoff response requires etc.) - should be runoff and groundwater recharge response (Arie S. ISSAR, Ben Gurion University of the Negev)	Addressed
3-96	A	4	28			Meaning unclear "runoff response requires threshold to occur" (Robert Wilby, Environment Agency of England and Wales)	Changed
3-97	A	4	32	4	32	Please, reformulate the sentence "Water is indispensable, in high volumes, to sustain life and, virtually, in every human activity" (Constanta-Emilia Boroneant, National Meteorological Administration)	No comment
3-98	A	4	32		41	So, drawing any general and universal conclusions such the ones listed in the Exec. Summary pgs. 3, say, #3 lines 25-30 or #4 lines. 32-41 may be questioned. (Nick Reynard, Centre for Ecology and Hydrology)	Adressed: Changes in the new ES
3-99	A	4	32	4	37	Please do not mix drinking water (of which there tends to be enough even under difficult circumstances, we only need about 1m3/pp per year) and the amount of water needed to feed us (1000 m3/pp per year) and maintain ecosystems. (Nick van de Giesen, Delft University of Technology)	Point taken
3-100	A	4	34			The reference to the Millennium Development Goals should be amended to read Millennium Development Goals´ target. In fact this issue is under target 10 of the MDG - 7 (Osvaldo Canziani, IPCC)	It has been changed.
3-101	A	4	36	4	37	It is stated that climate change will exacerbate water problems in the future due to restrictions caused by climate change yet later in the chapter a great deal of discussion is given to the role of adaptation and technology. Might it not be better to state that climate change will likely increase water restrictions where individuals or instititutions do not have the policies or economic capacity to adapt? (Harvey Hill, Prairie Farm Rehabilitation Administration)	No comment
3-102	A	4	37	4	37	Instead of "water problems" please, consider "water demands" (Constanta-Emilia Boroneant, National Meteorological Administration)	Disagree

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3-103	A	4	45			There are apparent trends …' Some trends are significant, but not at the scale of a region or the globle. Most long gauged records show NO trend. Statement misleading. (Christel Prudhomme, Centre for Ecology and Hydrology)	See TAR
3-104	A	4	45			What meaning has "apparent" here? May be “evident” would be more appropriated. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See TAR
3-105	A	4	49			Add "snow-melt induced" (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	No comment
3-106	A	5	0	22		Chapter 3.2: Almost no information is given on vulnerability (which seems especially interesting when it comes to fresh water resources). (Nick van de Giesen, Delft University of Technology)	New section 3.2
3-107	A	5	2			I propose to add at th end of the line"in some regions" (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	See TAR
3-108	A	5	6			Please specify why demand for water is falling in certain countries (piblic awareness or drop of population…) (Martin Savard, Geological Survey of Canada)	See TAR
3-109	A	5	14	5	17	This overview raises the question: will these topics receive attention in FAR (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	YES
3-110	A	5	21	5	21	Is the acronym SRES spelled out in another section of the review? It doesn't appear to be in this chapter. (Harvey Hill, Prairie Farm Rehabilitation Administration)	It is in the Glossary.
3-111	A	5	21			Some interested readers will only consult this chapter so please write out SRES. (Martin Savard, Geological Survey of Canada)	OK
3-112	A	5	22	5	23	Delete (Assessment…systems) (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	OK
3-113	A	5	22			"natural managed systems"? (Nick van de Giesen, Delft University of Technology)	OK
3-114	A	5	23			"...in physically-based and in natural managed systems" - this formulation is rather unclear !? (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	OK
3-115	A	5	23			'Assessment (…) is physically-based' : what does that mean? Not clear (Christel Prudhomme, Centre for Ecology and Hydrology)	OK
3-116	A	5	27			What about old adaptation techniques? Aren’t they useful still? (Kevin Trenberth, National Center for Atmospheric Research)	OK

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-117	A	5	30			"Section 3.2": Still need more input on sensitivity of water system to climate change, mostly to extreme events: heavy precipitation/drought (Constanta-Emilia Boroneant, National Meteorological Administration)	New Section 3.2.1
3-118	A	5	30	23	14	Section 3.2: This section should first of all focus on the sensitivity/vulnerability of the system to weather/climate and other stresses. The present focuss is on recent and current trends (especially 3.2.1 to 3.2.3). There appears to be a lot of overlap with Chapter 1. (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	OK
3-119	A	5	30			Comment on Section 3.2. The focus on Section 3.2 seems to be to look at trends in the relatively "near" term. Since we are talking of climate change the current situation should be placed in the context long enough for the reader to be convinced that the variations that we see currently are outside the range of natural variability. Why is this important? First, it obviously sheds light on the issue as to the likelihood of current changes being due to non-natural factors. Second, if changes of similar magnitude occurred in the past, this begs the question as to how -- and hiow well -- human and natural communities responded and coped with them. This would mean looking, wherever possible, at variations over past centuries, if not longer. That would help answer questions regarding whether current changes are within the bounds of natural variability. References that might help in this regard include: [1] Shapley, M.D., Johnson, W.C., Engstrom, D.R. and Osterkamp, W.R. 2005. Late-Holocene flooding and drought in the Northern Great Plains, USA, reconstructed from tree rings, lake sediments and ancient shorelines. The Holocene 15: 29-41. [2] Fye, F.K., Stahle, D.W. and Cook, E.R. 2003. Paleoclimatic analogs to twentieth-century moisture regimes across the United States. Bulletin of the American Meteorological Society 84: 901-909. [3] Ni, F., Cavazos, T., Hughes, M.K., Comrie, A.C. and Funkhouser, G. 2002. Cool-season precipitation in the southwestern USA since AD 1000: Comparison of linear and nonlinear techniques for reconstruction. International Journal of Climatology 22: 1645-1662. [4] Campbell, C. 2002. Late Holocene lake sedimentology and climate change in southern Alberta, Canada. Quaternary Research 49: 96-101. [5] Haque, C.E. 2000. Risk assessment, emergency preparedness and response to hazards: The case of the 1997 Red River Valley flood, Canada. Natural Hazards 21: 225-245. [6] Wilson, R. J., Luckman, B. H. and Esper, J. 2005. A 500 year dendroclimatic reconstruction of spring-summer precipitation from the lower Bavarian Forest region, Germany. International Journal of Climatology 25: 611-630. See, also, references in comment 12 (Indur Goklany, Office of Policy Analysis, Department of the Interior)	New section 3.2

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3-120	A	5	30			Section 3.2 is far too long, particularly as it is stated that section 3.4 is the "core" section of the chapter. Of all the sub-sections here, 3.2.6 probably provides the most concise and to the point example of an appropriate level of detail. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Point addressed
3-121	A	5	30	6	30	In 3.2 :"Current sensitivity/vulnerability", it is needed to give the time length of "current" in order to distinguish the time scale of these changes or variability(Is this observed variation related to natural climate variability or climate change ?) and to give definition of "sensitivity" as we (Chunzhen Liu, Water Information Center,MWR)	Common-sense interpretation
3-122	A	5	30			I think this section should include "trends" in the title. (Nick Reynard, Centre for Ecology and Hydrology)	Information on trendsin records removed now
3-123	A	5	43	6	30	This paragraph could be removed or merged with section 3.2.6 (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	SOD has a different structure regarding sections
3-124	A	5	43	6	30	These information are very general (Batima Punsalmaa, Institute of meteorology and Hydrology)	OK
3-125	A	5	43	5	49	Differentiate between Global water cycle and "regional components of water cycle" as the degree of human impacts are different. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	OK
3-126	A	5	44			I am not convinced that one should speak of a „paradigm shift“. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	OK
3-127	A	5	47			Substitute "sensitive" for "exposed and vulnerable". (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Section revised
3-128	A	5	48	5	49	The sentence " Land-use/land cover transforms topographical modification and compression of soil layers, including building cities and agricultural activities, have large impacts on water cycle." is unclear. Please, reformulate it. (Constanta-Emilia Boroneant, National Meteorological Administration)	OK
3-129	A	5	48			Meaning unclear "transforms topographical modification" (Robert Wilby, Environment Agency of England and Wales)	OK
3-130	A	5	49			put "urban" instead of "building cities" (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Section revised
3-131	A	5	50			Regarding water usages, the importanceof water use in energy generation, particulary as a cooling agent, is important because of the environmental impacts of warmer water. This issue is referred to in page 17 line 17 and in page 18 lines 49/50. Therefore, after “municipal” a comma should be added, followed with “energy generation”, so to read: “and municipal, energy generation and industrial water	addressed

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						usages..." (Osvaldo Canziani, IPCC)	
3-132	A	5		23		Some of the sub-sections of section 3.3 do not include discussion of sensitivities, vulnerabilities and trends, making them appear inconsistent. (Nick Reynard, Centre for Ecology and Hydrology)	Sections revised
3-133	A	6	0	8		The rationale for supporting the section almost entirely with the situation in Russia is unclear. Some examples from other parts of the world in addition to Russia would establish the relevance of the concern for a broader range of readers. (Rob de Loë, University of Guelph)	Section revised
3-134	A	6	0			If you like the concept of "virtual water", then I suggest incorporating material by Gleick (2003) and Falkenmark (2001). Both provide a good global overview that supports some of the ideas you're advancing in this section. Gleick, for instance, addresses the notion of "soft-path" solutions while Falkenmark makes the connection to water security. These are related topics that help to set the stage more broadly. Gleick, P.H. 2003. Global freshwater resources: soft-path solutions for the 21st century. Science, 302(28 November): 1524-1528. Falkenmark, M. 2001. The greatest water problem: the inability to link environmental security, water security and food security. International Journal of Water Resources Development, 17(4): 539-554. (Rob de Loë, University of Guelph)	Point taken
3-135	A	6	1	6	5	The sentence "These anthropogenic impacts on surface/subsurface …..is not dominant for precipitation but the local boundary condition matters." is too long and unclear. Please, reformulate it. (Constanta-Emilia Boroneant, National Meteorological Administration)	Revised
3-136	A	6	2			I see no surface or subsurface water cycle but components of a general water cycle consisting of stored amounts of water and fluxes of it. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Revised
3-137	A	6	5			Meaning unclear "when large-scale circulation…." (Robert Wilby, Environment Agency of England and Wales)	Revised
3-138	A	6	6	6	11	Figure is important to show that it is difficult to asses exact climate impact. This needs to be given a proper context. Now it is just one of the many things, showing there are many things. (Nick van de Giesen, Delft University of Technology)	Revised
3-139	A	6	7			Comment on Figure 3.1. Strike "consumptive" in the figure. It is unnecessary. Life style -- consumptive or not -- will inevitably affect land use, food production and	In our view, useful, simple figure, showing first-order effects only. Some referees suggest

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						GHG emissions. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	leaving ti out, others propose modifications (rendering it more complex).
3-140	A	6	7	0	0	chpt. 3.2: Fig. 3.1 should be complemented since most of the processes are influencing itself vice-versa, e. g. climate and landuse, hydrological cycle and water withdrawals,water withdrawals and food production, food production and demographic growth. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	See comment to 3-139
3-141	A	6	7			Figure 3.1. Clearly indicate the source. I am surprised that feedback relationship between water stress and the life styl ei snot enclosed. As presented this figure is incorrect and incomplete. In addition the figure does not include the link between the water cycle and the climate. Isn't this what this report is all about?????? (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	See comment to 3-139
3-142	A	6	7	6	14	Figure 3.1 is not very helpful in my view. It does not describe “impacts” as claimed. (Kevin Trenberth, National Center for Atmospheric Research)	See comment to 3-139
3-143	A	6	8			Figure 3.7- As indicated in lines 16 and 17 another arrow ending with a phrase like: " Use of natural resources and services", would improve Oki ´s diagram. (Osvaldo Canziani, IPCC)	Section revised
3-144	A	6	8			In Figure 3.1, I'd argue that "Land Use" directly affects "Water Withdrawals", e.g., new housing developments create demand for additional water supplies. This point is captured indirectly by the link between "Demographic and Economic Growth" and "Water Withdrawals", but could be emphasized more directly because certain types of land use lead to more demands on water than others. This is a point that is recognized later in the chapter. (Rob de Loë, University of Guelph)	See comment to 3-139
3-145	A	6	8			Figure 3.1. This figure doesn't really help me understand how the pathways influence the hydrological cycle. I suggest leaving it out, find a better one, or perhaps have a table listing these factors. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	See comment to 3-139
3-146	A	6	18	6	20	This statement seems to be not necessary as it is the general topic of the FAR. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	OK
3-147	A	6	19			land-use changes do not necessarily increase emission of GHGs, it can also be vice versa ! (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Yes
3-148	A	6	19			Please specify that the industrial activities in question here are based on fossil fuel	

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						consumption (hydroelectricity or nuclear energy would not generate the same problems) (Martin Savard, Geological Survey of Canada)	
3-149	A	6	20			Changes in vulnerability will also influence "necessary adaptation" (Robert Wilby, Environment Agency of England and Wales)	Point taken
3-150	A	6	23	6	30	As the concept of virtual water is not used in the impact assessment the question arises why it was introduced here. Suggestion: Delete it. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Point taken (section revised)
3-151	A	6	23	6	30	Discussion of the virtual water should be put in the context of climatic change and its impact on water. What is virtual water transport doing? How is water being redistributed? What is the importance of this transport on the overall water cycle? This issue deserves more serious discussion. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Point taken
3-152	A	6	23			Data on virtual water are of a very recent date. No time series are available. Hence, you do not know whether the trend is up or down. (Richard S.J. Tol, Uni. Hamburg)	Yes
3-153	A	6	23	6	30	Leave general discussion of globalization out. Very important, but not relevant here. (Nick van de Giesen, Delft University of Technology)	OK
3-154	A	6	28	6	30	detailed knowledge of "virtual water" is not only useful to assess local water scarcity, but it could be helpful to augment the efficiency of water use in near future e. g. by substituting grops with high water demand (e. g. rice) by plants with lower water consumption (e. g. wheat). Such plans are discussed at the moment in arid zone agricultural development in Iran. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	OK
3-155	A	6	33			Section 3.2.1 is not balanced, only the territory of Russia is covered with much details. Explanain whether is due to the fact that trends have been observed mostly only in this region or research results are available only around this region. (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Improved
3-156	A	6	33	8	42	(a) this entire section (3.2.1) is essentially based on findings in Russia and adjacent countries. This information is very valuable, but needs to be supplemented with similar results from other parts of the world; (b) in its present form, this section has limited "added value" because relevant facts are simply enumerated without well-defined organization and discussion of general implications - see for example Table	Improved

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						6 of Zhang et al (2001), p. 997. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-157	A	6	33	8	42	see: results of the UBA-research project Nr. 201 41 254: "Wahrscheinlichkeit für das Eintreten von klimatologischen Extremereignissen in Deutschland", project leader: Ch. D. Schoenwiese, Frankfurt (1.1.2003-31.12.2004) (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	Drastic shrinking of observation material
3-158	A	6	33			chpt. 3.2.1: This chapter should be complemented by results from other countries than Russia, e. g. "Plan national de l'eau de la Republique Algerienne", Evaluation des Ressources en eaux", Alger (2003) (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Russian track disappeared
3-159	A	6	33			Section 3.2.1. VERY POOR. Misleading headlines. Needs major revision and complete re-writing. Not acceptable in present form. Major references are missing, but strangely, the missing reference do NOT conclude on significance of trends and do not support climate change evidence - Text at present biased towards references with trends on extremes- A great deal of not verificable references: Abstract of conference paper (conference proceedings should not be acceptable for such high-level publication, and references are not even published paper but only abstracts), in Russian = not readible by most potential readers. Many statements (likely NOT to be true) are NOT supported by any reference (e.g. 'recent studies report that precipitation has become more intense in the late 20th century): This is NOT acceptable. Feel of overall lack of scientific integrety, even if the presence of non significant trends is mentionned (but lost into rest). Whole section needs sharpening as well as including other (the majority) published results on trends. (Christel Prudhomme, Centre for Ecology and Hydrology)	Due to the need to shrink, material on observed effects has been removed from 3.2, condensed, and handed over to LAs of Chapter 1. Only some elements are present in the new draft, mostly in introductory parts of section on future impacts (3.2.n).
3-160	A	6	35	6	40	English needs improving, see WG I chapter 3. (Kevin Trenberth, National Center for Atmospheric Research)	Yes
3-161	A	6	46	6	49	What are the references for this? (Kevin Trenberth, National Center for Atmospheric Research)	
3-162	A	7	5	7	7	These formulations need to be improved. In particular " the so-called rarer precipitation events" is a very inconvenient ! (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	
3-163	A	7	6	8	3	The authors may be interested in work of Gedney et al (submitted to Nature - I can supply to TSU) which detects an effect of plant stomatal responses to CO2 on hydrological changes over the 20th century. (Richard Betts, Met Office)	Included
3-164	A	7	6			The definition of rare events should be given more precise: "(1 in 50 or more year return period)"	Revised

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						(Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	
3-165	A	7	9	7	9	more work is needed for this section ("still needs more coordination with WGI findings") (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Section revised
3-166	A	7	9	7	33	I agree strongly with the bracketed comment that this short section on current trends in atmospheric variables should relate much more to the findings of WG1 (Nick Reynard, Centre for Ecology and Hydrology)	YES
3-167	A	7	11	8	42	Section 3.2.1. Needs to be consolidated. In particular, the authors should suggest what has caused the observed changes in runoff patterns; if the underlying mechanisms are not known, this should be stated. Also, this chapter (especially p. 8) is too much focussed on Eurasia, whereas a global perspective is required. The discussion of ice coverage is incomplete; as it is the focus of Chapter 1, this passage can probably be left out here (or a link should be provided to that chapter). (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Different sections in SOD
3-168	A	7	15	7	21	A reference on the remarkable oceans' warming due to greenhouse effect (Barnett P. .et al: "Detection of Anthropogenic Climate Change in the World Oceans", Science, 13 April 2001) and a paper on (Canziani O.F, Gimenez J.C, EPA contract, 2002) provide the basic information on the world atmosphere increasing water vapor content, change in atmospheric circulation and on series of daily precipitation data on the Argentina's Pampas. Other research papers refer to the relationship between the ENSO and snowfall on the high Andes, between 29º and 36º S, and their relation with snowmelt water availability in the dry western central region in Argentina (Canziani O. F, R. Quintela and M. Prieto, 1st National Comunication to UNFCCC, Buenos Aires, 1997). (Osvaldo Canziani, IPCC)	Section Revised
3-169	A	7	15	7	21	Your paragraph calls for references – I agree. For the basis of the increase in water vapor with temperature I would cite Held and Soden (2000). For the resulting increase in precipitation and its limits I would cite Allen and Ingram (2002)I would say that there is some regional evidence for increase in tropospheric water vapor content (New et al., 2000; ross and Elliott, 2001; Michwaner and Dessler, 2004; Trenberth et al., In Press). Allen, M.R., Ingram, W.J., 2002. Constraints on future changes in climate and the hydrologic cycle. Nature 418, 224-232. Held, I.M., Soden, B, J., 2000. Water vapor feedback and global warming. Annual Review of Energy and the Environment 25, 441-475	Interesting references but out of scope fot the shrinking (and more focussed) Chapter 3

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						Minschwaner, K., Dessler, A.E., 2004. Water vapor feedback in the tropical upper troposphere: Model results and observations. J. Climate 17, 1272-1282. New, M., Hulme, M., Jones, P.D., 2000. Representing twentieth-century space-time climate variability. Part II: development of 1901-96 monthly grids of terrestrial surface climate. J. Clim. 13, 2217-2238. Ross, R.J., Elliott, W.P., 2001. Radiosonde-based Northern Hemisphere tropospheric water vapor trends. J. Climate 14, 1602–1611. Trenberth, K.E., Fasullo, J., Smith, L., InPress. Trends and variability in column-integrated atmospheric water vapor. Climate Dynamics. (Thomas Huntington, U.S. Geological Survey)	
3-170	A	7	17	7	17	missing references (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	OK
3-171	A	7	18	7	18	If the water vapor content increases due to temperature rise, it is not so clear why this would increase the rainfall potential. (Nick van de Giesen, Delft University of Technology)	Revised
3-172	A	7	20	7	21	replace "low" by "all".You should also include her >the "changes in sesonal distribution of precipitation" (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Revised
3-173	A	7	20		21	I propose to wthdraw the expression "(there are both increase and decrease of precipitation over land in low latitudes)" because the term "low latitude" is not clear.The main trend is the decrease (example : the trend in the North Africa). (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Revised
3-174	A	7	20	7	10	Very unclear. Needs literature if true. (Nick van de Giesen, Delft University of Technology)	OK
3-175	A	7	23	7	25	This statement needs robust support from peer-reviewed results. (Sten Bergström, Swedish Meteorological and Hydrological Institute)	OK
3-176	A	7	23	7	25	Here I would be very careful because I believe that there is much uncertainty as to whether the data truly support increases in the frequency of extreme events – when you are referring to storms and floods. For example the following recent studies report no increases in frequency of flooding: Mudlesee et al. 2003; McCabe and Wollock, 2002; Lindstrom and Bergstrom, 2004; Vogel et al., 2002, Zhang et al., 2001). This should be discussed in the first paragraph of page 30 Section 1.3.2.5. Lindstrom, G., and S. Bergstrom. 2004. Runoff trends in Sweden 1807-2002.	Yes

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						Hydrol. Sci. J. 49:69-83. McCabe, G.J., and D.M. Wolock. 2002. A step increase in streamflow in the conterminous United States. Geophys. Res. Lett. 29(24), 2185, doi:10.1029/2002GL015999,2002. 29:38-1 to 38-4. Mudelsee, M., M. Börngen, G. Tetzlaff1, and U. Grünewald. 2003. No upward trends in the occurrence of extreme floods in central Europe. Nature 425: 166 - 169. Vogel, R., Zafirakou-Koulouris, A., Matalas, N.C., 2002. Frequency of record-breaking floods in the United States. Water Resour. Res. 37, 1723-1731. Zhang, X., Harvey, K.D., Hogg, W.D., Yuzyk, T.R., 2001b. Trends in Canadian stream flow. Wat. Resour. Res. 37, 987-998. And when it comes to increases in hurricanes it is noteworthy that, although some reports have found increases in storm intensity (Emanuel 2005) several recent papers find no increase for example: Time series analyses have found no evidence for an increase in tropical storm frequency (Easterling et al., 2000; Folland et al., 2001; Solow and Moore, 2002; Elsner et al., 2004), intensity (Free et al., 2004), or duration of storm season (Balling and Cerveny, 2003) during the 20th century. Balling Jr., R.C., Cerveny, R.S., 2003. Analysis of the duration, seasonal timing, and location of North Atlantic tropical cyclones: 1950-2002. Geophys. Res. Lett. 30, 10.1029/2003GL018404 Easterling, D.R., Evans, J.L., Groisman, P.Y., Karl, T.R., Kunkel, K.E., Ambenje, P., 2000. Observed variability and trends in extreme climate events: A brief review. Bulletin of the American Meteorological Society 81, 417-425. Elsner, J.B., Niu, X., Jagger, T.H., 2004. Detecting shifts in hurricane rates using a Markov Chain Monte Carlo approach. J. Clim. 17, 2652-2666. Emanuel, K. 2005. Increasing destructiveness of tropical cyclones over the past 30 years. Nature 436:686-688. Solow, A.R., Moore, L.J., 2002. Testing for trend in North Atlantic hurricane activity, 1900-98. J. Clim. 15, 3111-3114. Free, M., Bister, M., Emanuel, K., 2004. Potential intensity of tropical cyclones: Comparison of results from radiosonde and reanalysis data. J. Clim. 17, 1722-1727. (Thomas Huntington, U.S. Geological Survey)	
3-177	A	7	23		25	Section 3.2.1, : The statement reads: It was not definitively concluded about the change in extreme events of precipitation in the TAR, but the latest studies are suggesting possible increase in extreme events both torrential and scarce precipitation [need to add reference(s)]. Statements such as these only serve to lead the reader to a conclusion that has no basis in fact. As noted earlier, the words	See reply to 3-159

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						"intense" and "extreme," when used in this context are only relevant to the insinuation of increasing floods and droughts. Yet the studies of observed precipitation done to date provide no systematic or widespread evidence for an increase in precipitation rates that typically produce floods (i.e., >100 mm per day or > 200-400 mm over several consecutive days), nor do they support the notion that the number of consecutive days without precipitation is increasing to the point that drought frequency is increasing. If the reported increases in "intense" and "extreme" precipitation have no consequences vis-à-vis flood and drought hydrology, then inclusion of statements about them here has no meaningful relevance. This sentence should be deleted. (Harry F Lins, World Climate Programme-Water)	
3-178	A	7	23	7	25	NO reference: pointless statement. Not sure if literature can provide such reference, and disagree with statement. If not strongly supported by peer-reviewed journal paper (with significant trends on long records), DELETE (Christel Prudhomme, Centre for Ecology and Hydrology)	Observation material removed
3-179	A	7	23			Note that there has been some debate about whether changes in extreme events may be an artefact of the statistical methods employed. See for exampe: Michaels, P.J., Knappenberger, P.C., Frauenfeld, O.W. and Davis, R.E. 2004. Trends in precipitation on the wettest days of the year across the contiguous USA. International Journal of Climatology, 24, 1873-1882. (Robert Wilby, Environment Agency of England and Wales)	Observation material removed
3-180	A	7	25	7	25	missing references (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-181	A	7	25			Add references: Fowler, H.J. and Kilsby, C.G. 2003. Implications of changes in seasonal and annual extreme rainfall. Geophysical Research Letters, 30(13), 1720, doi:10.1029/2003GL017327. Fowler, H.J. and Kilsby, C.G. 2003. A regional frequency analysis of United Kingdom extreme rainfall from 1961 to 2000. International Journal of Climatology, 23(11), 1313-1334. (Hayley Fowler, Newcastle University)	Observation material removed
3-182	A	7	25	7	25	Here, and throughout, no literature is provided that proves an increase in any (surface water) extremes. It would, in any case, be extremely difficult to provide statistical proof given the fact that this concerns (very) high moments of the distributions, and that there are enormous differences between regions. If there is literature that goes beyond anecdotal evidence, even at regional scale, than this should be given a prominent place in support of the general line of reasoning. (Nick van de Giesen, Delft University of Technology)	Observation material removed

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3-183	A	7	27	7	30	Is there any reference for this paragraph? (Harvey Hill, Prairie Farm Rehabilitation Administration)	See reply to 3-159
3-184	A	7	27	7	30	NO reference. Findings doubtfull. Most published literature on lond-term series show NO significant trend except in West Africa. Reference in africa missing (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-185	A	7	27	7	28	How the current trends can be consistent with future projections (Batima Punsalmaa, Institute of meteorology and Hydrology)	
3-186	A	7	27			If there is an observed trend in global precipitation it should be presented here and discussed. If this statement is related to local trends only it could not be verified as the existing projections of the future regional distributions of precipitations among the globe differ strongly. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-187	A	7	28			I would like to write…….over land has increased in the midle and high altitudes…….. (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Changed
3-188	A	7	30	7	30	missing reference(s) and case(s) (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Changed
3-189	A	7	32	7	33	This sentence is unclear: do recent studies show that precipation extremes are more severe in the late 20th century ? Is this finding statistically significant ? Does it apply everywhere or in certain parts of the world ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See reply to 3-159
3-190	A	7	32	7	33	This statement needs robust support from peer-reviewed results. (Sten Bergström, Swedish Meteorological and Hydrological Institute)	Changed
3-191	A	7	32	7	33	Please, specify the regions where precipitation has become more intense in the late 20th century. Need to add references. (Constanta-Emilia Boroneant, National Meteorological Administration)	See reply to 3-159
3-192	A	7	32	7	33	The above mentioned EPA study covers fully the statistical detected trends in frequency and intensity of extreme precipitation events. (Osvaldo Canziani, IPCC)	See reply to 3-159
3-193	A	7	32	7	33	Add reference to Klein Tank, A.M.G. and 38 co-authors: 2002, Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment. Int. J. Climatol. 22, 1441-1453. Klein Tank, A.M.G. and Können, G.P. (2003). Trends in indices of daily temperature and precipitation extremes in Europe 1946-99. J. Climate 16, 3665-3680. (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	See reply to 3-159

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3-194	A	7	32	7	33	Section 3.2.1: See comments from P7 Line 23-25 -- the sentence is irrelevant vis-à-vis flood and drought hydrology and only serves to mislead the reader. It should be deleted. (Harry F Lins, World Climate Programme-Water)	Changed
3-195	A	7	32	7	33	'Recent studies (…) in late 20th century' Not valid statement, likely to be wrong. Must have a reference or delete (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-196	A	7	33			Give references! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Changed
3-197	A	7	33	7	33	Needs literature. (Nick van de Giesen, Delft University of Technology)	Changed
3-198	A	7	35	7	40	this entire paragraph is not adequately documented. It would be useful to present specific examples and publications; also, it would be useful to comment on how the changing fall/winter/spring flows may be affecting the ice regime of rivers. Some relevant citations: Zhang, X., Harvey, K. D., Hogg, W. D., Yuzyk, T. R. (2001) Trends in Canadian streamflow, Water Resour. Res., 37, 987-998. Prowse, T. and Beltaos, S. 2002. Climatic control of river-ice hydrology: a review. Hydrological Processes, Volume 16, Issue 4, 805-822. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Material removed
3-199	A	7	35	7	36	Please, add due references to support the sentence : "Increase in surface temperature changes …even if precipitation does not change." (Constanta-Emilia Boroneant, National Meteorological Administration)	Changed
3-200	A	7	35	7	40	MUST have references or delete (Christel Prudhomme, Centre for Ecology and Hydrology)	Changed
3-201	A	7	36	7	38	References:Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095; Hyvvärinen; V. 2003. Trends and Charateristics of Hydrological Time Series in Finland. Nordic Hydrology, 34(1/2),2003,71-90; Bergström, S., Andreasson, J., Beldring, S., Carlsson, B., Graham, P., Jónsdóttir, J., Engeland , E., Turunen , M. and Vehviläinen, B. 2003. Climate change impacts on water resources in the Nordic countries, State of the art and discussion of principles. CHIN, Nordic Council of Ministers. ISBN 9979-68-120- 9. (Bertel Vehviläinen, Finnish Environment Institute)	See reply to 3-159
3-202	A	7	37	7	37	missing references (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Changed

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3-203	A	7	37	7	37	For references, see also article by Brutsaert&Parlange (already quoted elsewhere). (Nick van de Giesen, Delft University of Technology)	
3-204	A	7	38			A recent reference for the trend towards precipitation falling more frequently as rain rather than snow is (Huntington, 2004). Huntington, T. G., G. A. Hodgkins, B. D. Keim, R.W. Dudley, 2004. Changes in the proportion of precipitation occurring as snow in New England (1949 to 2000), Journal of Climate, 17:2626-2636. (Thomas Huntington, U.S. Geological Survey)	Thanks. Observation material removed
3-205	A	7	38			less snow… it is not every where, there is increasing trend in cold regions (Batima Punsalmaa, Institute of meteorology and Hydrology)	Thanks. Observation material removed
3-206	A	7	39	7	40	what is the source of the statement made in the last paragraph ? Is it generally applicable or only in certain areas ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-207	A	7	39	7	40	Since springtime snowmelt starts earlier due to Earth's warming it means that mean daily, monthly or seasonal air temperatures also increase, changing the water balances. This is important in arid regions, modifying critically water balances and effecting crops. (Osvaldo Canziani, IPCC)	
3-208	A	7	42	7	49	similar comments also apply to this paragraph (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	o.k.
3-209	A	7	42			Other references on increases in streamflow include a global analysis of (Labat et al., 2004) and an analysis of most major basins in the continental USA (McCabe and Wolock, 2002; Walter et al., 2004; Mauget, 2004; Gagnon and Gough, 2002) but no increases detected in Canada (Zhang et al., 2001; Burn and Hag Elnur, 2002). Labat, D., Goddéris, Y., Probst, J.L., Guyot, J.L., 2004. Evidence for global runoff increase related to climate warming. Advances in Water Resources 27, 631-642. Walter, M.T., Wilks, D.S., Parlange, J.-Y., Schneider, R.L., 2004. Increasing evapotranspiration from the conterminous United States. J. Hydrometeorology 5, 405–408. Burn, D.H., and M.A. Hag Elnur. 2002. Detection of hydrologic trends and variability. J. Hydrol. 2565:107-122. Mauget, S. 2004. Low frequency streamflow regimes over the central United States: 1939-1998. Climatic Change. 63:121-144. McCabe, G.J., and D.M. Wolock. 2002. A step increase in streamflow in the conterminous United States. Geophys. Res. Lett. 29(24), 2185,	See reply to 3-159

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						doi:10.1029/2002GL015999,2002. 29:38-1 to 38-4. Gagnon AS, Gough WA. 2002. Hydro–Climatic Trends in the Hudson Bay Region, Canada. Can. Water Resour. J. 27: 245–262. Zhang, X., K.D. Harvey, W.D. Hogg, and T.R. Yuzyk. 2001. Trends in Canadian stream flow. Wat. Resour. Res. 37:987-998. (Thomas Huntington, U.S. Geological Survey)	
3-210	A	7	43	7	44	YES 'Drawing conclusions from short record is NOT rigourous' - Then rest of paragraph is misleading as based on 30-years records. This cannot be a valid example of trends, as the period of record and the length are not sufficient for significance (see Robson et al, 1998; Robson, 2002; Lindstrom & Bergstrom, 2004; Burn & Elmur, 2002; Hisdal et al., 2001) (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-211	A	7	44	7	49	The authors have done a very thorough job of doing literature review on each of the sub-topics covered in the chapter. As is expected, many of the references address regional studies and in terms of the connection to climate, the conclusions sound contradictory. As an example, I refer to page 7, lines 44-49. (Soroosh Sorooshian, University of California-Irvine)	See reply to 3-159
3-212	A	7	45	7	45	does "significant trends" imply 5% significance probabilty ? This term appears very often in the chapter, and it might be helpful to define it quantitatively at the very start. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See reply to 3-159
3-213	A	7	45	7	49	Statement misleading as only based on short record. DELETE whole paragraph if no reference added. MUST put here reference to non significant trends/ conclusions saying evidence that climate change is happening CANNOT be made yet (e.g. Svensson et al., 20005; Mudelsee et al., 2003; Kundzewicz et al., 2005; Lindstrom & Bergstrom, 2004 etc....) (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-214	A	7	45			Add the significant trends together with the methodological approach which was used to specify it. Is the time period 1960 to 90 still representative for 2005? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-215	A	7	47	7	49	Please, complete the sentence " There are increasing trends in north-eastern Europe " , with due references, "but decreasing trends prevails in Iberian Peninsula " - add reference . For the Danube river in its lower basin decreasing trends has been reported for the last decades of the last century (Rimbu et al. 2002). For Africa and Asia , due references are needed.	See reply to 3-159

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						(Constanta-Emilia Boroneant, National Meteorological Administration)	
3-216	A	7	49			instead of "but decreasing trends prevails in Iberian Peninsula, Africa etc." should be Iberian Peninsula, Italy, Israel etc. (Dragoni 1998, Alpert et al. 2002) (Arie S. ISSAR, Ben Gurion University of the Negev)	See reply to 3-159
3-217	A	7	49			…. and Asia (references ?) (Batima Punsalmaa, Institute of meteorology and Hydrology)	
3-218	A	8	1	8	42	This collection of mostly Russion examples should be supplemented by examples from other regions representative for the whole globe. For Sweden I suggest that you consider the following two peer-reviewed references:Lindström, G. and Bergström (2004) S. Runoff trends in Sweden, Hydrological Sciences Journal, 49, 69-83 and:Lindström, G. and Alexandersson, H. (2004). Recent mild and wet years in relation to observation records and future climate change in Sweden. Ambio 33:4-5, 183-186 (Sten Bergström, Swedish Meteorological and Hydrological Institute)	See reply to 3-159
3-219	A	8	1	8	37	Extensive example in Russia: only one region of the world, with a too large part compared to rest. Not acceptable references: grey literature, abstracts in Russian. The few other references are NOT YET published, so cannot be verified. Significance of trends not mentionned, or method used, or the length of records. Spatial extend of trends is something important to take into account when assessing trends (ignoring spatial and auto correlarions leads to different results in significance of trends see e.g. Douglas et al., 2000 and Cunderlick & Burn, 2004). (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-220	A	8	1	8	4	Vague, period not clear, what are references? (Kevin Trenberth, National Center for Atmospheric Research)	See reply to 3-159
3-221	A	8	1	8	37	A lot of emphasis on Russian findings. Seems a bit anecdotal: some go some go down. Leave out or shorten. (Nick van de Giesen, Delft University of Technology)	See reply to 3-159
3-222	A	8	1			The discussion of long-term trends would be better served by a summary table, giving an overall impression of increases (+) and decreases (-) by region, with supporting publication. The present content largely overlooks the continents of Africa, S.America and Australasia. (Robert Wilby, Environment Agency of England and Wales)	See reply to 3-159
3-223	A	8	2			What is the time scale of this statement about changes: During the last 20, 30, 40, 50 years and in comparison with what time period? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159

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3-224	A	8	6	8	12	the above quoted paper by Zhang et al. (2001) provides detailed information on seasonal trends in the discharge of Canadian Rivers (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See reply to 3-159
3-225	A	8	6	8	12	does the term "evident trend" mean "significant trend" or does it refer to visual impact ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See reply to 3-159
3-226	A	8	6	8	37	A lot of information for one region. Can be summarised such as done for other regions on page 7 (line 42..49) (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	See reply to 3-159
3-227	A	8	6	8	37	This is all about Russia, what about other countries? How good is this information? Where is the assessment? Lacks balance. (Kevin Trenberth, National Center for Atmospheric Research)	See reply to 3-159
3-228	A	8	12	8	12	Please, consider the following references to this paragraph: Berezovskaya, S., Yang, D. and Kane, D.L., 2004, Compatability analysis of precipitation and runoff trends over the large Siberian watersheds. Geophysical research letters, vol 31, L21502. Callaghan, T.V., Bjorn, L.O., Chernov, Y., Chapin, T., Christensen, T.R., Huntley, B., Ims, R.A., Johansson, M., Jolly, D., Jonasson, S., Matveyeva, N., Panikov, N., Oechel, W., Shaver, G., Schaphoff, S. and Sitch, S. 2004. Effects of changes in climate on landscape and regional processes, and feedbacks to the climate system. Ambio, vol 33, no 7, 459-468. Yang, D. Kane, D.L., Hinzmann, L.D., Zhang, X., Zhang, T. and Ye, H., 2002. Siberian Lena River hydrological regime and recent change. Journal of geophysical research, vol 107, D23, 4694. Yang, D., Ye, B. and Shikolomanov, A., 2004b. Discharge Characteristics and Changes over the Ob watershed in Siberia. Journal of Hydrometeorology, vol 5, 595-610. (Constanta-Emilia Boroneant, National Meteorological Administration)	See reply to 3-159
3-229	A	8	14	8	14	"additional 2500": what does this amount represent in terms of normal inflows ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See reply to 3-159
3-230	A	8	15	8	17	"increased by 5%": is the increase statistically "significant" ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See reply to 3-159
3-231	A	8	15	8	16	How significant is an increase of 5 % with regard to the uncertainties of discharge measurements? (Andreas Schumann, Institute of Hydrology, Water Resources Management and	See reply to 3-159

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						Environmental Engineering)	
3-232	A	8	20			A "tendency towards decrease" is not really a scientific statement. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-233	A	8	23			As it is difficult to differentiate quantitatively between climatic driven changes and human activities the lines 19 to 23 should be deleted. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-234	A	8	25	8	31	The comment for page 3 applies here as well. (Donald Burn, University of Waterloo)	o.k.
3-235	A	8	25	8	31	It should be possible to give more information on the causes these increases in winter low flow : whether it can be caused by increases of air temperature during P events, i.e. shift from snowfall to rain, or less freezing processes in rivers, or temporal snow melt events. (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Changed
3-236	A	8	25	8	31	Increase in winter disvharge in southern Finalnd also:Hyvvärinen; V. 2003. Trends and Charateristics of Hydrological Time Series in Finland. Nordic Hydrology, 34(1/2),2003,71-90 (Bertel Vehviläinen, Finnish Environment Institute)	See reply to 3-159
3-237	A	8	29			What is meant by "everywhere"? Globally? (Martin Savard, Geological Survey of Canada)	See reply to 3-159
3-238	A	8	33	8	37	The sentence: "Air temperature rise during the last twenty years …(by up 20C) - may be it is a typing mistake !!. Also, this sentence should be completed with more explanations for particular cases. (Constanta-Emilia Boroneant, National Meteorological Administration)	See reply to 3-159
3-239	A	8	33	8	37	Why is this discussion limited to Russia and adjacent countries? These trends are also evident in North America and other places. For Example see the following: Beltaos, S., and T.D. Prowse. 2002. Effects of climate on mid-winter ice jams. Hydrol. Proc. 16:789-804. Futter MN. 2003. Patterns and Trends in Southern Ontario Lake ice Phenology. Environ. Mon. Assess. 88: 431-444. Hodgkins, G A, R. W. Dudley, and T. G. Huntington. 2005 Changes in the number and timing of ice-affected flow days on New England rivers, 1930-2000. Climatic Change 71: 319-340. Hodgkins, G.A., I.C. James, and T.G. Huntington. 2002. Historical changes in lake ice-out dates as indicators of climate change in New England. Intl. J. Climatology 22:1819-1827.	See reply to 3-159

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						Huntington, T. G., G. A. Hodgkins, R. W. Dudley, 2003, Historical trend in river ice thickness and coherence in hydroclimatological trends in Maine. Climatic Change 61: 217-236. Kuusisto, E., and A.-R. Elo. 2000. Lake and river ice variables as climate indicators in Northern Europe. Verh. Internat. Verein. Limnol. 27:2761-2764. Quayle, W.C., L. Peck, H. Peat, J.C. Ellis-Evans, and P.R. Harrigan. 2002. Extreme Responses to Climate Change in Antarctic Lakes. Science 295:645. Yoo, J.C., and P. D'Odorico. 2002. Trends and fluctuations in the dates of ice break-up of lakes and rivers in Northern Europe: the effect of the North Atlantic Oscillation. J. Hydrol. 268:100-112. Zhang, X., K.D. Harvey, W.D. Hogg, and T.R. Yuzyk. 2001. Trends in Canadian stream flow. Wat. Resour. Res. 37:987-998. (Thomas Huntington, U.S. Geological Survey)	
3-240	A	8	33	8	34	20oC is a huge temperature increase during a 20 year period. Is this "20oC" correct? (Levent Kavvas, University of California, Davis)	See reply to 3-159
3-241	A	8	33	8	37	Decrease of lake ice cover period in Finland about 30 days: Ref:Korhonen, J.2005. Suomen vesistöjen jääolot.Suomen ympäistökeskus/Finnish Environment Institute. Suomen ympäristö 751. Helsinki.www.ymparisto.fi/julkaisut. English summary. (Bertel Vehviläinen, Finnish Environment Institute)	See reply to 3-159
3-242	A	8	39	8	42	does this paragraph imply that the previously mentioned trends did not focus on unregulated streams that are subject to minimal, if any, withdrawals ? My own experience with relevant literature is that hydrometric stations are screened to ensure pristine or at least stable hydrologic conditions (see Zhang et al. 2001). (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See reply to 3-159
3-243	A	8	39	8	42	Here, the following reference can be added : McClelland, J.W., Holmes, R.M., Peterson, B.J. and Steiglitz, M., 2004. Increasing river discharge in the Eurasian Arctic: consideration of dams, permafrost thaw and fires as potential agents of change. Journal of geophysical research, 109. D18102. (Constanta-Emilia Boroneant, National Meteorological Administration)	See reply to 3-159
3-244	A	8	39	8	42	A reference on the modelled results on the Amazon basin pluvious forest deforestation, which would show up to a 50% decrease in projected precipitations and, no doubt, will change river discharge in this basin, is suggested. A possible example is (Ref: Molion L.C.B., 1996.- Global Climate Impacts of the Amazonia Deforestation, from the publication on " GHG emissions from developing countries point of view" eds. Pinguelli R.L. and M.A. dis Santos- COPPE, Federal University	See reply to 3-159

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						of Rio de Janeiro, pp 78-89). (Osvaldo Canziani, IPCC)	
3-245	A	8	39	8	42	This statement should be moved to the top of 3.2.1. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-246	A	8	41	8	42	Very important statement - Should be in executive summary (Christel Prudhomme, Centre for Ecology and Hydrology)	Interesting comments, but it is not being incorporated as so in the ES. This is much chapter 1 (attribution)
3-247	A	8	45			Section 3.2.2: well organized section that "adds value" by discussing global results and their interpretation (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	OK
3-248	A	8	45	10	22	"soil water", "snow and ice", "groundwater" are connected regional and local with mass movement (landslides, blockfalls and rock avalanches); "mass movements" occur, when a large input of water occurs over longer periods ... see: Raetzo, H. and Latettin, O. (2003) In: OcCC (2003): Organe consultatif sur les changements climatiques/Beratendes Organ für Fragen der Klimaänderung: Extremereignisse und Klimaänderung. Bern, September 2003, pp. 73-76. (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	OK
3-249	A	8	47			Comment on Section 3.2.2. It should be noted in this section that in controlled plant growth experiments, soil moisture is higher at elevated CO2 levels. Refs: [1] Morgan, J.A., LeCain, D.R., Mosier, A.R. and Milchunas, D.G. 2001. Elevated CO2 enhances water relations and productivity and affects gas exchange in C3 and C4 grasses of the Colorado shortgrass steppe. Global Change Biology 7: 451-466. [2] Morgan, J.A., Pataki, D.E., Korner, C., Clark, H., Del Grosso, S.J., Grunzweig, J.M., Knapp, A.K., Mosier, A.R., Newton, P.C.D., Niklaus, P.A., Nippert, J.B., Nowak, R.S., Parton, W.J., Polley, H.W. and Shaw, M.R. 2004. Water relations in grassland and desert ecosystems exposed to elevated atmospheric CO2. Oecologia 140: 11-25. [3] Nelson, J.A., Morgan, J.A., LeCain, D.R., Mosier, A.R., Milchunas, D.G. and Parton, B.A. 2004. Elevated CO2 increases soil moisture and enhances plant water relations in a long-term field study in semi-arid shortgrass steppe of Colorado. Plant and Soil 259: 169-179. [4] Owensby, C.E., Ham, J.M., Knapp, A.K. and Auen, L.M. 1999. Biomass production and species composition change in a tallgrass prairie ecosystem after long-term exposure to elevated atmospheric CO2. Global Change Biology 5: 497-506. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	See reply to 3-159
3-250	A	8	47			What means "water table", the surface of the water-saturated soil zone? (Andreas Schumann, Institute of Hydrology, Water Resources Management and	

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						Environmental Engineering)	
3-251	A	8	48			please provide a reference concerning the link between soil moisture and surface meteorological conditions. Note in addition that simulations of soil moisture conditions in order to later model climate change is stretching the proxy a little far (page 9, lines 6-20). (Martin Savard, Geological Survey of Canada)	
3-252	A	9	1	9	20	this paragraph on soil moisture is indeed very week and needs complete revision (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Removed
3-253	A	9	1			Section 3.2.2. No comment on impact of land use and water abstraction on soil moisture deficit. Needs say length of records used to assess trends. If less than 50 years, evidence is doubtful, and needs lots of caution in statement. (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-254	A	9	1	9	4	Data from over 600 stations which include a large variety of global climates showed increasing long term trend in surface top 1 m soil moisture content during summer for the stations with longest records in the United States, countries of the former Soviet Union, and Mongolia. Information for Mongolia is not consistant with the trend in figure 3.2. (Batima Punsalmaa, Institute of meteorology and Hydrology)	See reply to 3-159
3-255	A	9	6	9	25	It is difficult to see the point in including this modelling exercise from Mongolia. (Sten Bergström, Swedish Meteorological and Hydrological Institute)	See reply to 3-159
3-256	A	9	6	9	20	It needs to be clarified whether all that is said here refers to the global situation (I doubt it does), and what are the regional patterns. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Material removed
3-257	A	9	6	9	20	The time increment of the calculations on soil moisture (annual values?) is not evident (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Material removed
3-258	A	9	6	9	20	Note in addition that simulations of soil moisture conditions in order to later model climate change is stretching the proxy a little far (page 9, lines 6-20). (Martin Savard, Geological Survey of Canada)	Material removed
3-259	A	9	6	9	20	In general, one of my real concerns with forcings and such within the GCMs is the lack of in situ soil moisture observations. I know we are pushing hard and making progress (albeit slow!) in this arena, but in both the extreme flooding/drought extremes of the hydrologic cycle, this is a glaring gap. How can we model when we are so unsure of the dynamics/status of the current state of the soil column, which varies greatly in space and time? This doesn't seem to be addressed in any great detail and is dismissed all too easily. The authors here have at least mentioned the gap, but then easily replace the lack of observed values with a seemingly easy	Material removed

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						estimated answer. In addition, the sentence beginning with Line 16 and ending on Line 20 seems a bit long and disjointed. There would appear to be a word/thought missing before ,very on Line 20.....perhaps "was" is omitted? (Mark Svoboda, National Drought Mitigation Center)	
3-260	A	9	6	9	20	This is one model among many. What about other studies? This is not an assessment. (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-261	A	9	6	9	20	Simulated soil moisture changes from Finland. Increase in autumn and early spring about 15%. Decrease in summer about 15% : Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095 (Bertel Vehviläinen, Finnish Environment Institute)	See reply to 3-159
3-262	A	9	13	9	13	"corresponds fairly well": Quality of graph is such that that can not be ascertained, also due to large offset. Is there a number, like a Nash-Sutcliffe efficiency, or is that meant by correlation, which then should be correlation coefficient? (Nick van de Giesen, Delft University of Technology)	See reply to 3-159
3-263	A	9	14	9	15	While comparison of 1 degree soil moisture fields to in-situ measurements may be somewhat useful over releatively homogenous land surfaces (e.g. Mongolian grasslands) it is likely not as useful over other areas of the world (especially in areas with substanial fragmented wetlands, forests, or water bodies at sub 1 degree resolution). It seems that some caution should be raised as to the lack of appropriate in-situ data at a scale suitable for comparison to the LSM's (even if run off line at a higher resolution) and the need for more nested higher resolution LSM's (e.g. use of RCM's) to derive soil moisture fields. (Richard Fernandes, Natural Resources Canada, Government of Canada)	See reply to 3-159
3-264	A	9	14			How representative is the series for JJA soil moisture at Mongolia of global trends? (Robert Wilby, Environment Agency of England and Wales)	See reply to 3-159
3-265	A	9	15	9	15	the word hardly appears to be out of context (Harvey Hill, Prairie Farm Rehabilitation Administration)	o.k.
3-266	A	9	16	9	20	This paragraph is very unclear. (Nick van de Giesen, Delft University of Technology)	Revised
3-267	A	9	22	9	23	Figure 3.2 should be of better quality. Source shoul dbe indicated. What is the value of this figure and what is the message from it? (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Deleted
3-268	A	9	23			Fig. 3.2: the caption should include the source (Hirabayashi et al 2005); it would be helpful to some readers to define "JJA"	Deleted

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						(Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-269	A	9	23			Fig. 3.2. This figure basically shows a model validation for one site (?) in Mongolia, can be dropped (also, its legend is unclear: what is „frac. of no-station area“?). (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Deleted
3-270	A	9	23			Figure 3.2. Misleading title. Figure does NOT show any annual trend but a series of soil moisture values (Christel Prudhomme, Centre for Ecology and Hydrology)	Deleted
3-271	A	9	28	10	22	Since the chapter should not be exclusively based on empirical estimations, shown in some research papers, but rely on basic observations, this segment of the chapter should mention the need for evaporation (evaporation pan) and evapotranspiration (lysimeters or evapotranspirometer) measurements. Decision makers must be informed that these observations and respective monitoring are fundamental in agrometeorological work as well as they are important in water managment. The same is applicable to soil moisture. This need shall be spelt out to bring decision making to consider implementation possibilities. This is a very important issue for the CCT Water and for the AR4 TP on water. (Osvaldo Canziani, IPCC)	See reply to 3-159
3-272	A	9	30	10	12	As the controversy about the causes of changing pan evaporation still goes on, please add "maybe" at the end of line 12 at page 10 (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Not in Chapter 3
3-273	A	10	1	10	13	This discussion on pan evaporation was also present in some form in Chapter 1 of WG1. Perhaps it should be consolidated with the box on the subject in Chapter 1. (Richard Fernandes, Natural Resources Canada, Government of Canada)	Not in Chapter 3
3-274	A	10	1	10	22	Although ET is a decisive process in the land- and in the ocean surface energy turnover, and therefore in the whole climate system, our observational basis of this parameter is still quite poor because of the difficulties of its continuous monitoring. And the interpretation of pan evaporation data with view to its information content for real evaporation, as pointed out, is still very questionable. (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Changed
3-275	A	10	1	10	13	The following papers could be cited in Line 3, China (…) such as Xie et al. (2003), Su and Xie (2003), Xie et al. (2004), Yuan et al.(2004). Cited papers: Su F., Z. Xie, 2003: A model for assessing effects of climate change on runoff in China. Progress in Natural Progress, 13(9), 701-707. Xie Z., F. Su, X. Liang, Q. Zeng, Z. Hao, Y. Guo, 2003: Applications of a surface runoff model with Horton and Dunne runoff	Material re-organized

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						for VIC. Advances in Atmospheric Sciences. 20(2), 165-172. Xie Z., Q. Liu, F. Su, 2004: An application of the VIC-3L land surface model with the new surface runoff model in simulating streamflow for the Yellow River basin. IAHS Publiction No.289, 241-248. Yuan F., Z. Xie, Q. Liu, H. Yang, F. Su, X. Liang, L. Ren, 2004: An application of the VIC-3L land surface model and remote sensing data in simulating streamflow for the Hanjiang River Basin. Canadian Journal of Remote Sensing, 30(5),680-690. (Zhenghui Xie, Institute of Atmospheric Physics, Chinese Academy of Sciences)	
3-276	A	10	6			please define „terrestrial evaporation“. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Changed
3-277	A	10	6			Meaning unclear "inverse relationship between pan evaporation and terrestrial evaporation…" (Robert Wilby, Environment Agency of England and Wales)	Changed
3-278	A	10	13			Meaning unclear "decreasing pan evaporation indicates increasing terrestrial evaporation." (Robert Wilby, Environment Agency of England and Wales)	Changed
3-279	A	10	15	10	18	To this section I would recommend adding the results of Golubev et al (2001) for long-term trends in ET using massive weighing lysimeters which I think is the only data set for long term direct measurements in existence. This study reported increases in ET in grassland steppe and forested locations in Russia. Golubev, V.S., Lawrimore, J.H., Groisman, P.Y., Speranskaya, N.A., Zhuravin, S.A., Menne, M.J., Peterson, T.C., Malone, R.W., 2001. Evaporation changes over the contiguous United States and the former USSR: a reassessment. Geophys. Res. Letters 28, 2665-2668. (Thomas Huntington, U.S. Geological Survey)	Observation material left out
3-280	A	10	15	10	22	Here I propose to add eventually the following paragraph : " Within the last 30 years quite comprehensive studies on ET have been conducted in Switzerland, including combined energy balance, soil moisture and interception studies, long term catchment and river basin monitoring of lowland , pre-alpine an alpine regions, and weighing lysimeter monitoring. All this, including digital terrain models and land use data , allowed the development of physically well based hydrological model components and the computation of real evapotranspiration for the whole area of Switzerland in a grid scale 500 and 1000 m and over the period of 1981 - 2000 (Hydrological Atlas of Switzerland, Bern , 1995 ..2004, Federal Office of Topography and Geographisches Institut der Universität Bern)." -----The reviewer would be prepared to provide and contribute, if requested, ET time series	See reply to 3-159

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						graphs from longterm river basin monitoring, based on the water balance equation, for various river basins of Switzerland (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	
3-281	A	10	17			What is the time scale of this statement - within the last century or over the last five years? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-282	A	10	18	10	18	Consider to add reference: Szilagyi, 2001 :Szilagyi, J., 2001. Modeled areal evaporation trends over the conterminous United States, Journal of Irrigation and Drainage Engineering, 127(4): 196-200. (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	o.k.
3-283	A	10	18			Paragraph should distinguish between actual and potential evaporation. (Robert Wilby, Environment Agency of England and Wales)	Changed
3-284	A	10	20	10	22	Satellite data from which evapotranspiration can be deduced need to be mentioned here (as well as programmes such as the GSWP). (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Changed
3-285	A	10	20	10	22	This paragraph says "a few more years of data are needed" to make reliable conclusions about terrestrial and global evaporation. The text should be expanded to indicate how many years of data are required to draw conclusions (with what precision) on trends in evapotranspiration. (Chuck Hakkarinen, retired (2002) from Electric Power Research Institute)	Changed
3-286	A	10	21	10	21	The abbreviation AGCM is used here, and again on Pg. 36, line 48. AGCM stands for atmospheric general circulation model, a component of an AOGCM. Is this a typo or do the authors really mean AGCM? If they do, an explanation is needed of why just the atmospheric portion of the AOGCM was used. (Lenny Bernstein, IPIECA)	OK. Point taken
3-287	A	10	25			Section 3.2.3: though I have not, as a rule, checked the accuracy and completeness of the citations, I could not help noticing that most of the cited works in this section are not listed under "References". (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See reply to 3-159
3-288	A	10	25			Section 3.2.3: this section essentially addresses glaciers, with a small portion devoted to snow. There could have been more emphasis on N. American glaciers, since much work has been done on that continent as well. The presentation would be improved by occasional summary/interpretation of various groups of facts that are abundantly cited. Tabulate where possible, or even show changes on a map. An obvious gap is that lake/river ice and permafrost, both very important topics from	See reply to 3-159

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						the socio-economic and ecological perspectives, are not discussed. It is noteworthy that this topic was identified in section 3.1 (p. 5, lines 14-17) as "insufficiently tackled in TAR" (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-289	A	10	25	12	23	I found this section to be rather poorly written. The content is, for the most part, fine, but it requires further organiztion. The section could be strengthened by making a clear separation between general behaviours noted for snow and ice and then talking more about the specific examples, which either support the general observations or are examples of contrary behaviour. At present, it seems that the two are intermixed resulting in confusion as to whether a particular result is general or case specific. (Donald Burn, University of Waterloo)	See reply to 3-159
3-290	A	10	25	11	41	Too much references on Asian situation. Coordinate with Chapter 10, and augment references on other regions. (Osvaldo Canziani, IPCC)	See reply to 3-159
3-291	A	10	25	12	23	"soil water", "snow and ice", "groundwater" are connected regional and local with mass movement (landslides, blockfalls and rock avalanches); "mass movements" occur, when a large input of water occurs over longer periods ... see: Raetzo, H. and Latettin, O. (2003) In: OcCC (2003): Organe consultatif sur les changements climatiques/Beratendes Organ für Fragen der Klimaänderung: Extremereignisse und Klimaänderung. Bern, September 2003, pp. 73-76. (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	OK
3-292	A	10	25	12	23	This section seems to be written with respect to Eurasia only. What about, for example worldwide studies of Dyurgerov (2003) and Oerlemans (2005) Arendt et al., (2003) Rignot et al (2003). Arendt, A.A., K.A. Echelmeyer, W.D. Harrison, C.S. Lingle, and V.B. Valentine. 2002. Rapid Wastage of Alaska Glaciers and Their Contribution to Rising Sea Level. Science 297:382-386. Dyurgerov, M., 2003. Mountain and subpolar glaciers show an increase in sensitivity to climate warming and intensification of the water cycle. J. Hydrol. 282, 164-176. Oerlemans, J.H. 2005. Extracting a Climate Signal from 169 Glacier Records. Science 5722:675-677. Rignot, E, A. Rivera, and G. Casassa., 2003 Contribution of the Patagonia icefields of South America to sea level rise. Science 302:434-437. (Thomas Huntington, U.S. Geological Survey)	See reply to 3-159

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3-293	A	10	25			chpt. 3.2.3: Concerning glacier degradation the detailed swiss and austrian studies should be cited (ETH Zürich) (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	See reply to 3-159
3-294	A	10	27			Section 3.2.3. Can be shortened. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	See reply to 3-159
3-295	A	10	27			Section 3.2.3 : Section not general enough, and needs a lot of tightening up as well as links with Chapter 1 text. The great majority of references are NOT in the reference list: this is not acceptable, as it is not possible to check the facts stated, or the method used to describe such trends. Some facts are NOT true (data are NOT rich in the Himalayas), and some key references are missing, such as the World Glacier Monitoring Service publication such as Glacier Mass Balance Bulletin. There is NO mention of the little ice age, that is claimed by some authors to have continued until early 19th-century, as to explain the retreat of glaciers: this retreat may be just a 'back to normal' phase: this needs to be added if the authors don't want to mislead the reader into something that may not be true (i.e. anthropogenic changes are the only cause). There is too many examples from the Former Soviet Union, and the whole section should be more general. Some paragraphs repeat each other. The first part should include results from the whole globe, and be more general rather than regional. (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-296	A	10	31			Although note that there is some evidence that Karakoram glaciers are expanding - possibly due to an increase in winter preciptiation and reduction in summer temperatures causing less ablation over the last 40 years (see Archer, D.R. and Fowler, H.J. 2004. Spatial and temporal variations in precipitation in the Upper Indus Basin, global teleconnections and hydrological implications. Hydrology and Earth System Sciences, 8(1), 47-61 and Fowler, H.J. and Archer, D.R. Conflicting signals of climatic change in the Upper Indus Basin. Journal of Climate, in press). (Hayley Fowler, Newcastle University)	See reply to 3-159
3-297	A	10	33			" ..55 % of its glaciers.. " - is it volume or area % ? (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	See reply to 3-159
3-298	A	10	35			As the most readers will not know the Byrranga Mountains and the size of glaciers there this information is not very helpful. May be the example of Austrian glaciers would be more informative. There is a very informative analysis available for Austrian glaciers. Please contact G. Bloeschl to integrate these information. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159

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3-299	A	10	37	11	7	Due to uncertainties the percentage calculations should be cited without decimal point (e. g. 43 % 56 % etc.) (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	See reply to 3-159
3-300	A	10	37	11	2	There is too much references on Former Soviet Union studies, and not enough in the rest of the world (such as the American continent). NONE of the references can be checked, some because not yet published, or missing in the reference list! The paragraphs could be condensed, and merged with following paragraphs for a wider outview of the state of the glaciers. (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-301	A	10	48	10	49	I did not understand what was meant by attained the phase in this context (Harvey Hill, Prairie Farm Rehabilitation Administration)	See reply to 3-159
3-302	A	10	49			eventually that sentence should be " melt does not any more increase runoff" (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	See reply to 3-159
3-303	A	10				This whole chapter 3.2.3 needs complete revision - providing missing regional results, - and improvement of its structure (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	See reply to 3-159
3-304	A	11	4	11	7	Very detailed info for global report unless these islands somehow signify something larger (Nick van de Giesen, Delft University of Technology)	See reply to 3-159
3-305	A	11	9	11	27	Clarify whether meltwater rates are referring to glaciered basin surface or just glacier surface. Somehow it is not completely clear from the context, especially in the first para. (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	See reply to 3-159
3-306	A	11	9	11	16	The recession since the 18th century could be claimed to be caused by the end of the little ice age. This must be clearly stated, as it may not be a result of anthropogenic climate change. Ignoring the little ice age may fuel genuine critisims of the text and conclusions. Some references are way outdated (1979!!), and must be removed. Again, missing from reference list. (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-307	A	11	18	11	27	Short term trends (20 years) are not sufficient to provide constructive evidence of any change. The whole paragraph does not seem to bring any useful information, and should be deleted. (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-308	A	11	18	11	28	Thi ssection of the report should more explicitly address the issue of earier freshet and its impact of typical spring runoff in Noerthern Hemisphere. I am finding, like in many places in this report, a very uneven regional discussion. It will very hard to	See reply to 3-159

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						use this material if the search for information on the impacts is not better organized and more clearly presented (suggested tables and graphs with clear conclusion of each section that summarizies the findings by the region. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	
3-309	A	11	29			Results from the two papers above should also be added into this section (Hayley Fowler, Newcastle University)	See reply to 3-159
3-310	A	11	29	11	41	The claim 'effect of changing climate …. Winter precipitation characteristic' MUST be justified by appropriate peer-reviewd literature based on long-term records and significant trends. Where these phenomenoms appear must also be stated - without such informations, the statement is useless. Text on single year results are not scientifically valid (reference to 1998 and 1999), and must be deleted. Reference MUST be added on claims that the Himalayas are 'already' experiencing climate change. The whole paragraph lacks reference and scientific justification of statements (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-311	A	11	29	11	29	Here and throughout, the use of "summer" and "winter" in not very useful. When is winter in Namibia? (Nick van de Giesen, Delft University of Technology)	See reply to 3-159
3-312	A	11	32	11	33	in this context it does not make much sense, if you give such singular extreme record data of 1998 and 1999, and the formulations "in the recent past " and "as elsewhere" are not at all helpful. (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	See reply to 3-159
3-313	A	11	37	11	41	the same sentence is shown up twice (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	See reply to 3-159
3-314	A	11	38	11	41	The sentence in these lines is repeated on lines 44-47. (Levent Kavvas, University of California, Davis)	See reply to 3-159
3-315	A	11	43	11	47	the same sentence is shown up twice (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	See reply to 3-159
3-316	A	11	43	12	2	Repetition with previous paragraph. The statement 'air temperature rise and changes in precipitation regime in the monsoon climate ARE THE reasons of glacier degradation' is NOT TRUE. They are likely reasons, but other phenomenons may also have an effect. Reference of Dyurgerov is missing from reference list (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-317	A	11	44			"Recent studies…" repeats text from previous paragraph (Robert Wilby, Environment Agency of England and Wales)	See reply to 3-159
3-318	A	11	48			Dyurgerov not in ref. list	Thanks

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						(Martin Savard, Geological Survey of Canada)	
3-319	A	11	49			Dyurgerov 2004 not in refs (Thomas Huntington, U.S. Geological Survey)	Thanks
3-320	A	11	49	11		: Citation"Dyurgerov,2004" missing in references (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Thanks
3-321	A	12	4	12	10	Reference to a recent paper: “Living and dying with glaciers: people’s historical vulnerability to avalanches and outburst floods in Peru” (Carey M., Global Planetary Change, Elsevier, 2004) is necessary. Further coordination with Chapters 1 (Observed Changes in Glaciers) and the regional chapters is necessary. (Osvaldo Canziani, IPCC)	See reply to 3-159
3-322	A	12	12	12	23	You have not included a number of studies showing decreases in snow cover extent and snow water equivalent from North America: Armstrong, R.L., Brodzik, M.J., 2001. Recent Northern Hemisphere Snow Extent: A Comparison of Data Derived from Visible and Microwave Satellite Sensors. Geophys. Res. Lett. 28, 3673-3676. Brown, R.D. 2000. Northern Hemisphere snow cover variability and change. Journal of Climate 13:2339-2355. Laternser, M., and M. Schneebeli. 2003. Long-term snow climate trends of the Swiss Alps (1931-99)*. Int. J. Climatol. 23:733 - 750. Mote, P.W., A.F. Hamlet, M.P. Clark, and D.P. Lettenmaier. 2005. Declining mountain snowpack in western North America. Bull. Amer. Met. Soc. 86:39–49. Scherrer, S.C., C. Appenzeller, and M. Laternser. 2004. Trends in Swiss Alpine snow days: The role of local- and large-scale climate variability. Geophys. Res. Lett. 31:L13215, doi:10.1029/2004GL020255. Ueda, H., M. Shinoda, and H. Kamahori. 2003. Spring northward retreat of Eurasian snow cover relevant to seasonal and interannual variations of atmospheric circulation. Intl. J. Climatology 23:615-629. (Thomas Huntington, U.S. Geological Survey)	See reply to 3-159
3-323	A	12	12	12	23	Again, too many references from FSU studies. There is an inbalance of the whole text (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-324	A	12	12	12	23	Decrease of snow water equivalent in southern Finland but increase in Lapland northern Finland in areal snow equivalents and snow line obesrvations: Hyvvärinen; V. 2003. Trends and Charateristics of Hydrological Time Series in Finland. Nordic Hydrology, 34(1/2),2003, 71-90 (Bertel Vehviläinen, Finnish Environment Institute)	See reply to 3-159

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3-325	A	12	13			See also: Regonda, S., B. Rajagopalan, M.P. Clark, and J. Pitlick, 2005. Seasonal Cycle Shifts in Hydroclimatology over the Western United States, Journal of Climate, 18, 372-384. (Robert Wilby, Environment Agency of England and Wales)	See reply to 3-159
3-326	A	12	13			For an overview of declining snowpack in the Western US, see: Mote P.W., A.F. Hamlet, M.P. Clark, and D.P. Lettenmaier, 2005. Declining mountain snowpack in western North America. Bulletin of the American Meteorological Society, January 2005, pp39-49. (Robert Wilby, Environment Agency of England and Wales)	See reply to 3-159
3-327	A	12	18			Here a map of Russia to show the regions of changes would be helpful. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-328	A	12	21			Is there really a snow cover statistics for days with snow depths not exceeding 1 cm ? (as described) or is there a statistic of days without snow cover above 1 cm? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-329	A	12	26			Section 3.2.4: many cited works in this section are not listed under "References" (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Adjusted
3-330	A	12	26	14	30	This paragraph must be coordinated with the regional chapters. One of the larger aquifers between Argentina, Bolivia, Brazil and Paraguay (Guarani's aquifer) is under full analysis now. Further, this section 3.2.4 does not mention the severe problems resulting from natural contamination with poisonous metals (mainly Ar and F) already affecting more than 100 million people over all the world, including developed countries (USA) and more millions in the near future because of increasing underground water mining, due to higher water requirements stemming from the Earth ´s warming. In this section, coordinated with section 3, water quality, decision makers would appreciate references on available water potabilization methods relative to poisonous underground water. (Osvaldo Canziani, IPCC)	There is a great possibility that millions in the near future will be affected because of increasing groundwater mining, due to higher water requirements stemming from the Earth´s warming.
3-331	A	12	26	14	30	In order to enrich the paragraph, I would suggest the Authors of the chapter to consider the paper: Cambi C., Dragoni W. (2000): Groundwater, recharge variability and climatic changes: some consideration out of the modelling of an Appenninic spring. Hydrogeology, vol. 4, ed. BRGM, pp. 39 - 53. http://www-b.unipg.it/denz/CambiDragoni.pdf The paper points out that:	In the case of aquifers feeding more than one spring, any variations of the recharge will cause not only a variation of the discharge of the springs but also a variation of the general pattern of flow, so that the climatic variation will have different impact on the various springs. The impact will be grater on the

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						- Some springs in Italy are showing a decrease of the discharge due to the climatic trend going on in the area. - In the case of aquifers feeding more than one spring, any variations of the recharge will cause not only a variation of the discharge of the springs but also a variation of the general pattern of flow, so that the climatic variation will have different impact on the various springs. The impact will be grater on the springs fed by local flow rather then on those fed by regional flow. (Walter Dragoni, Università di Perugia)	springs fed by local flow rather then on those fed by regional flow. Some springs in Italy are showing a decrease of the discharge due to the climatic trend going on in the area (Cambi and Dragoni, 2000). Cambi C., Dragoni W. (2000): Groundwater, recharge variability and climatic changes: some consideration out of the modelling of an Appenninic spring. Hydrogeology, vol. 4, ed. BRGM, pp. 39 - 53.
3-332	A	12	26	14	30	"soil water", "snow and ice", "groundwater" are connected regional and local with mass movement (landslides, blockfalls and rock avalanches); "mass movements" occur, when a large input of water occurs over longer periods ... see: Raetzo, H. and Latettin, O. (2003) In: OcCC (2003): Organe consultatif sur les changements climatiques/Beratendes Organ für Fragen der Klimaänderung: Extremereignisse und Klimaänderung. Bern, September 2003, pp. 73-76. (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	Groundwater is in connection with soil water and snow and ice. Any large input or and especially output of water over extensive periods may cause landslides, block-falls and rock avalanches as mass movements. Such movements are prone to damage the infrastructure.
3-333	A	12	26			Section 3.2.4. A bit long, with lack of scientific justification to statements. Lacks reference (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-334	A	12	27			Permafrost melt not discussed or referred to in this section on ice. (Martin Savard, Geological Survey of Canada)	See reply to 3-159
3-335	A	12	28	12	28	The opening sentence is of little value without a brief outline of what are the many ways by which climate and groundwater are related. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Climate and groundwater are related through the rock outcrops which constitute recharge areas.
3-336	A	12	28	13	5	It is not always clear to what study and region the information refers. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	See reply to 3-159
3-337	A	12	29	12	29	What exactly does "high confidence" mean ? Is it quantifiable ? There are several other references to confidence, such as medium confidence, etc. It would be helpful if these terms were clearly defined at the start of the report or where they first appear. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	In the sense of FAR
3-338	A	12	32			Terms like "catchment", "basin" and "watershed" are not used in the same way everywhere in the world. It might be helpful for the authors to standardize their own language, or at least to clarify. For instance, I would expect the Meuse to be a "basin" rather than a catchment.	Corrected in the text

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						(Rob de Loë, University of Guelph)	
3-339	A	12	34	12	38	It is not clear from this statement if the sensitivity of groundwater level versus temperature increases as temperature increases or if simply increases in temperature result in large changes in groundwater levels. The follow on statement of explanation (line 39 on this page) was not clear to me. (Richard Fernandes, Natural Resources Canada, Government of Canada)	Corrected in the text
3-340	A	12	34	12	49	Here local and regional studies are mixed with generalizations which are not valid for all climatic regions of the Earth. The complexity of groundwater formation and the interconnections of the different impacts is not sufficiently considered. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Corrected
3-341	A	12	37	12	38	'The high … groundwater levels' - Needs reference otherwise delete (Christel Prudhomme, Centre for Ecology and Hydrology)	Corrected
3-342	A	12	38			This statement can not be valid for arid or even semi-arid regions. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	This statement can not be valid for arid or even semi-arid regions.
3-343	A	12	41	12	49	Sentences from line 41 "The impact..." on could be consolidated to state that: 1. changes in groundwater recharge due to climate variability may have a lesser impact on groundwater levels in basins where there is a hydraulic connection between river and aquifers 2. the hydrogeological setting plays a large role in determining aquifer sensitivity to climate changes (Richard Fernandes, Natural Resources Canada, Government of Canada)	Changes in groundwater recharge due to climate variability may have a lesser impact on groundwater levels in basins where there is a hydraulic connection between river and aquifers. The hydrogeological setting plays a large role in determining aquifer sensitivity to climate changes.
3-344	A	12	41	12	44	it should be made more clear in the discussion of the reaction of groundwater with climatic variations, that local specific conditions of the drainage networks,of vegetation, landuse, geology and geomorphology are important parameters, and therefore any generalizations from a few site studies have to be drawn with great care. (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Local specific conditions of the drainage networks, vegetation, landuse, geology and geomorphology are important parameters, and therefore any generalizations from a few site studies have to be drawn with great care.
3-345	A	12	43		45	If you're referring to Allen, et al 2003, then it's inappropriate to refer to "southern Canada"; those authors are writing about British Columbia (which is not southern Canada). The aquifer in question is in southern British Columbia! (Rob de Loë, University of Guelph)	Corrected
3-346	A	12	44			Allen, et al is listed as 2003 in the reference list – and 2004 in the body. There seem to be other problems like this (e.g., there's a Schmidt, et al 2004 but no Schmidt and	Corrected

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						Dikau 2004 as cited). Presumably you'll catch those at editing… (Rob de Loë, University of Guelph)	
3-347	A	12	44	12	49	Surely this is also a function of location, topography, etc. (Kevin Trenberth, National Center for Atmospheric Research)	Added: also a function of location, topography, etc.
3-348	A	12	45		49	The use of the terms "sensitive" and "sensitivity" will need her. some extra remarks on the sensitivity of hydrologic systems to climatic variations (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	See reply to 3-159
3-349	A	12	49			Reference (Schmidt and Dikan 2004) missing (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Included
3-350	A	13	0			There are many, many missing references from the list at the end of the chapter which are mentioned in the text. See for example, page 13. (Soroosh Sorooshian, University of California-Irvine)	Included
3-351	A	13	1		5	More attention should be paid to study locations. As in comment 9, it is unclear at this point (page 13, line 1) what "the region" is. I couldn't figure it out from the reference list because the cited reference is not included. This problem repeats throughout the chapter, in other words, experiences in a specific place are presented in support of a global or universal assertion. This can be misleading. (Rob de Loë, University of Guelph)	Section revised
3-352	A	13	2			Please provide more information about the isotopic trend and on what it implies (more mositure from cold or warmer seasons) (Martin Savard, Geological Survey of Canada)	more mositure from cold or warmer seasons
3-353	A	13	2	13	5	Text very unclear (Nick van de Giesen, Delft University of Technology)	Corrected
3-354	A	13	3			What "region"? (Robert Wilby, Environment Agency of England and Wales)	Deleted
3-355	A	13	4			Do these statements still refer to the semiarid region of southern Canada? (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	No
3-356	A	13	5	13	5	Bajjali, and Abu-Jabal, 2002 do not appear to be in the references (Harvey Hill, Prairie Farm Rehabilitation Administration)	Deleted
3-357	A	13	5			Bajjali and Abu-Jabal not in ref list. (Martin Savard, Geological Survey of Canada)	Deleted
3-358	A	13	7	13	30	This alinea refers to impact studies and should be used in 3.4 (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	OK
3-359	A	13	7	13	34	This passage should be removed to Section 3.4.4. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	OK
3-360	A	13	7	13	8	"spring recharge retreats towards winter" - does this happen because of earlier	

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						snowmelt or/and higher percentage of liquid precipitation ?- if so, you should point out on this. (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	
3-361	A	13	7	13	30	these presentation are mainly related to climate change rather than to current sensitivity, it would be better to move it into 3.4.4 (Chunzhen Liu, Water Information Center,MWR)	OK
3-362	A	13	7	13	18	Must add references to bold statement - Is there any evidence on record? There is no compelling evidence on surface water yet, so doubt that grounwater shows anything. Reference needs adding that are based on LONG record if any trends to be significant before making such statements (Christel Prudhomme, Centre for Ecology and Hydrology)	Changed
3-363	A	13	7	13	30	This part of the chapter is very weak. The results of studies based on models are quoted without reference to the basic assumptions used. Many of these studies are not more than analyses of model sensitivities. E.g. "Rise in temperature and decrease in precipitations lead to a reduction of groundwater recharge". This statement is not valid if the groundwater recharge period is winter where the effect of evaporation on recharge is low. Some statements are trivial e.g. "groundwater recharge in mountains is smaller than in the plains". What means "climate trends have good correlations with groundwater level variations" (Line 16)? Trends can result in trends only but not in variations if there would be a correlation. I suggest to delete this part (Line 7 to Line 30) completely. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-364	A	13	7	13	14	What is the evidence? What references? (Kevin Trenberth, National Center for Atmospheric Research)	See reply to 3-159
3-365	A	13	7			What climate change? (Kevin Trenberth, National Center for Atmospheric Research)	See reply to 3-159
3-366	A	13	7	13	30	This is all small-scale spot studies, with local dependencies on topography, soils, etc and no large picture. (Kevin Trenberth, National Center for Atmospheric Research)	See reply to 3-159
3-367	A	13	11	13	12	In which direction is groundwater recharge affected by vegetation changes? Should be clarified. (Sten Bergström, Swedish Meteorological and Hydrological Institute)	See reply to 3-159
3-368	A	13	14	13	15	Disagree with statement that in shallow aquifers temperatures are the main factors etc. To my opinion at least for dry regions precipitation is always the main factor. (precipitation may change with temperature and thus influence water levels) suggest to omit or revise this statement	Temperature and precipitation are interchanged.

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						(Arie S. ISSAR, Ben Gurion University of the Negev)	
3-369	A	13	14	13	15	The idea that shallow aquifers are more affected by T than by P seems rather nonsensical (Nick van de Giesen, Delft University of Technology)	Corrected.
3-370	A	13	16	13	18	I am not sure if the Chen et al. 2004 result is a high confidence result chiefly because their methodology was to develop an empirical correlation between air temperature, percip and recharge for an aquifer assuming the system was in steady state (at least for developing the correlation function) and then applying the GCM anomalies for these two fields using the correlation function to estimate projected recharge. This approach does not consider the impact of higher temperatures on snow melt and inflitration that may supply a large portion of recharge for Canadian aquifers. (Richard Fernandes, Natural Resources Canada, Government of Canada)	OK
3-371	A	13	16	13	18	Vague, what period? What models. This is not high confidence. (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-372	A	13	16			What "climate trends"? (Robert Wilby, Environment Agency of England and Wales)	OK
3-373	A	13	19	13	30	Impact study results - Remove and put in section 3.4. Only modelling exercice, no evidence of climate change already occuring. Must mention which models (GCMs) and assumptions used to obtain results (Christel Prudhomme, Centre for Ecology and Hydrology)	OK
3-374	A	13	19			Yosoff et al. (2002) missing from refs (Robert Wilby, Environment Agency of England and Wales)	OK
3-375	A	13	26	13	30	This study is in contrast to the Chen et al. 2004 study in that a hydrological model was used to account for a number of interconnected flows and storages. As such, the climate impact of recharge even under steady state conditions was small due to rivers providing more net recharge along banks to aquifers to compensate for loss of recharge from the land surface. (Richard Fernandes, Natural Resources Canada, Government of Canada)	Add: This study is in contrast to the Chen et al. 2004 study in that a hydrological model was used to account for a number of interconnected flows and storages. As such, the climate impact of recharge even under steady state conditions was small due to rivers providing more net recharge along banks to aquifers to compensate for loss of recharge from the land surface.
3-376	A	13	30	13	34	Allen et al and Wessel et al. not in ref list (Martin Savard, Geological Survey of Canada)	Corrected: Allan et al 2003
3-377	A	13	32	13	34	What happens if droughts are connected with warning? Are loads or concentrations discussed here?	Add: If droughts are connected with warming then the nitrate concentration will increase

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						(Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	further.
3-378	A	13	32	13	34	"climate change " is vague. How is it affected? (Kevin Trenberth, National Center for Atmospheric Research)	Added: For instance,
3-379	A	13	34			Wessel 2004 not in refs (Thomas Huntington, U.S. Geological Survey)	
3-380	A	13	36			This is contradictory to line 45 on p. 13, in that it remains unclear whether climate effects on groundwater recharge are large or small. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	
3-381	A	13	37	13	39	Hypothetical. (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-382	A	13	41	13	42	References? (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-383	A	13	41			This statement only applies to unconfined aquifers (Robert Wilby, Environment Agency of England and Wales)	Add: This statement only applies to unconfined aquifers.
3-384	A	13	45	13	48	The sentence "Climate effects on mean annual groundwater recharge and streamflow are small…counteracting increasing evapotranspiration induced by the temperature rise and decreasing precipitation…" contradicts the earlier material in this section which provides ample evidence from the literature on the significant reduction of groundwater recharge by climate change. Among climatic variables, radiation, not temperature, plays the most important role in determining latent heat flux (ET) from the land surfaces (Yoshitani,J. et al. 2002. "Regional-scale hydroclimate model", Chp 7, in Watershed Models of Large Watershed Hydrology, ed. by V.P. Singh and D.K.Frevert, Water Resour. Pub.LLC.) (Levent Kavvas, University of California, Davis)	NO
3-385	A	13	45	13	48	this depends very much on the type of vegetation and should not be generalized ! (Herbert Lang, Institute for Atmospheric and Climate Science ETH)	Add: not to be generalized
3-386	A	13	45	13	48	This should be rephrased. Higher atmospheric CO2 increase or maintain equal the internal pressure in leaves to external CO2 pressure and favors plant growth. However this is only true in regions where forests are not submitted to toxic atmospheric pollution such as SO2 or O3 (see Savard et al, Journal Env. Quality 2004, Geochimica Cosm. Acta 2005) (Martin Savard, Geological Survey of Canada)	Rephrase: Higher atmospheric CO_2 increase or maintain equal the internal pressure in leaves to external CO_2 pressure and favors plant growth. However this is only true in regions where forests are not submitted to toxic atmospheric pollution such as SO_2 or O_3.
3-387	A	13	45	13	48	The stomatal conductance story does not hold for C4 plants in the (already) semi-arid regions of the world (Nick van de Giesen, Delft University of Technology)	Add: The stomatal conductance story does not hold for C4 plants in the (already) semi-arid regions of the world.

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3-388	A	13	45			See general comments about CO2 and stomatal resistence (above) (Robert Wilby, Environment Agency of England and Wales)	OK
3-389	A	13	46	13	48	what about evaporation? Reducing stomata does not reduce wilting. (Kevin Trenberth, National Center for Atmospheric Research)	Add: Reducing stomata does not reduce wilting.
3-390	A	14	1			Delete 'Impact of climate change on groundwater are well established' This is NOT supported by evidence of long records. (Christel Prudhomme, Centre for Ecology and Hydrology)	Deleted: well established but
3-391	A	14	1			"climate change" vague. What variables, what change? (Kevin Trenberth, National Center for Atmospheric Research)	Add: (temperature, precipitation, humidity, radiation)
3-392	A	14	1	14	6	Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095: 'The increased precipitation and snowmelt will inevitably increase groundwater storages in winter both in southern and northern Finland (Fig. 12). During the longer summers this increase may turn into a reduction of groundwater in southern Finland. Small groundwater storages, which are filled every winter and depleted in summer, are very prone to drying (Fig. 13). The long dry periods resulting from the longer summers and higher total evaporation from soil and lakes, may cause shortages in water supplies based on the use of groundwater.' (Hydrological water balance mode simulation results with climate change scenarios). (Bertel Vehviläinen, Finnish Environment Institute)	Add: The increased precipitation and snowmelt will inevitably increase groundwater storages in winter both in southern and northern Finland. During the longer summers this increase may turn into a reduction of groundwater in southern Finland. Small groundwater storages, which are filled every winter and depleted in summer, are very prone to drying. The long dry periods resulting from the longer summers and higher total evaporation from soil and lakes, may cause shortages in water supplies based on the use of groundwater (Vehviläinen and Huttunen, 1997). Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095:
3-393	A	14	4			Table 3.1: "some hydrological events"??? (Christel Prudhomme, Centre for Ecology and Hydrology)	Not understood
3-394	A	14	8	14	15	This statement seems to be specific to one case study area, but the area is not identified implying that the comments refer to groundwater in general, which I do not believe is valid. (Donald Burn, University of Waterloo)	OK
3-395	A	14	8			Ditto above for point about potential impacts of climate change on groundwater supplies in the upper carbonate aquifer. This is a specific finding from a study in Manitoba, but it's presented as being globally relevant	Added: Manitoba

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						(Rob de Loë, University of Guelph)	
3-396	A	14	8	14	15	It is not clear why there is a sudden reference to "the upper carbonate aquifer". If the authors decide to keep this example, they should mention where it is and introduce the subject as to why this is pertinent here. (Martin Savard, Geological Survey of Canada)	OK
3-397	A	14	8			"climate change" vague. What variables, what change? What is the "upper carbonate aquifer"? (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-398	A	14	8	14	8	What is "carbonate aquifer"? (Nick van de Giesen, Delft University of Technology)	Added: (karstic groundwater reservoir)
3-399	A	14	8			This section is non sequitor. Why specifically "upper carbonate aquifer"? (Robert Wilby, Environment Agency of England and Wales)	OK
3-400	A	14	12	14	13	This seems really far-fetched and not measurable (Nick van de Giesen, Delft University of Technology)	Yes, not measurable
3-401	A	14	12			Specifiy "changes in hydraulic properties" (Robert Wilby, Environment Agency of England and Wales)	Added: Hydraulic properties change due to the expansion of solution cavities in karstic groundwater terrain.
3-402	A	14	16			I propose to add "The space and temporal modifications of the distribution of precipitations have a direct impact on the supply of the underground water". (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Added: The space and temporal modifications of the distribution of precipitations have a direct impact on the supply of the underground water.
3-403	A	14	17	14	40	I think you need references to back up the statements that climate change is likely resulting in increases in salt water intrusion. Chapter 1 of WG2 line 14 cites Zhang 2001 as evidence for this. Chapter 1 of WG2 states that there is an absence of evidence for saltwater intrusion in intertidal zones page 34 line 28. (Thomas Huntington, U.S. Geological Survey)	Take from Chapter 1
3-404	A	14	17	14	30	Paragraph NOT supported by references. Impact statement and not observational evidence - Delete or move to 3.4. Must mention models (GCMs) and assumption used to obain results (Christel Prudhomme, Centre for Ecology and Hydrology)	Move to 3.4
3-405	A	14	17	14	30	This is redundant with 3.4.4. It is a function of models, scenarios etc. (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-406	A	14	17			"climate change" vague. What variables, what change? (Kevin Trenberth, National Center for Atmospheric Research)	OK

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3-407	A	14	22	14	30	The text starting with "For two small…" is repeated verbatim on page 38, lines 6-14. Though it is sometimes difficult to distinguish beween current vulnerability and future impacts, it would be preferable to eliminate the repetition. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	OK
3-408	A	14	33			Section 3.2.5: Gaps in this section relate to (a) flash floods; and (b) floods caused by river ice jams (both identified as insufficiently covered in the TAR). (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Material removed from Chapter 3.
3-409	A	14	33			Section 3.2.5 concerns me. Even with the qualifications, my sense is that the authors are saying that floods and droughts are worse due to climate change. That conclusion may be inappropriate given that other drivers explain the increase in flood damages (see comment no. 13). Kabat and van Schaik (2003) -- see reference above -- offer a more balanced evaluation using many of the same sources. A more nuanced evaluation in this section would therefore be appropriate. (Rob de Loë, University of Guelph)	Material removed from Chapter 3
3-410	A	14	33			As noted in comment 8, a longer term perspective is needed to establish that current changes are extarordinary. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Material removed from Chapter 3
3-411	A	14	33			Section 3.2.5. NOT GOOD SECTION - NEEDS MAJOR REVISION. Not well structured, not well referenced. Conclusions misleading. Lack of scientific integrity. There is a need to make a difference between what has been observed recently, and attribution of that to climate change. E.g. floods of 2002 were rare, but occured also in the past, and are not a proof of climate change (e.g. Mudelsee et al., 2003) (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-412	A	14	33	17	20	Some additional (UK) comments on section 3.2.5 below, including references that seem to have been missed: The last decade has been notably warm across the UK and characterized by substantial hydrological volatility – with widespread drought conditions (e.g. in 1995/96 and 2004) and exceptional flood episodes (e.g. spring 1998, winter 2000/01 and early 2003). A number of significant trends in annual runoff and flood magnitude (in Scotland especially) have been identified (e.g. Black & Burns, 2002; Werrity, 2002; Hannaford & Marsh, 2006). However, nationwide studies of flood trends concluded that the evidence for climatic effects is inconclusive (Robson et al. 1998; Robson, 2002), with most trends being attributable to climate variability rather than climate change. Increases in runoff observed in maritime northern and western areas have parallels with atmospheric circulation patterns associated with the	Material removed from Chapter 3

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						increasing NAOI in the recent past (Shorthouse & Arnell, 1997; Hannaford et al.2005), so recent changes may reflect climatic variability – although it is important to consider that recent variability in the NAOI itself may be a function of underlying climate change (Gillet et al. 2002). Few compelling signals have been observed in low flows. Hisdal et al. 2002 found varying regional patterns of increasing and decreasing trends in drought indices. Trends associated with the pervasive impact of man (heavy abstraction rates in particular) on river flow regimes can be readily identified. However, where hydrological variability is climate-driven any apparent trends are normally very sensitive to the timeframe within which analyses are undertaken. Hannaford and Marsh (2006) analysed low flow trends in a network of undisturbed catchments, and found no evidence of pronounced decreases in low flows. When time series of 50 years or more are considered, the most generic signal emerging is of perturbations about a relatively stable mean – initial work suggests that this applies to trend appraisals of runoff, flood magnitude and low flows, and studies of reconstructed river flows show that recent volatility has analogues in longer series of reconstructed flows extending into the 19th century (Jones & Lister, 1998, Environment Agency, 2004). However, relatively few analyses of long river flow records have been undertaken; this is a major research need to put recent trends in a fuller historical context. Changes in evaporative demands (e.g. increasing PE) and rainfall patterns (e.g. a tendency towards wetter winters and drier summers) can be recognized over the last 30 years but lengthy rainfall series suggest that natural seasonal variations have been a continuing feature of the UK climate (Mayes, 1996; Jones & Conway, 1997; Osborn et al 2001; Fowler & Kilsby, 2003). Importantly in relation to hydrological risks associated with climate change, some of the recent climatic tendencies have been beneficial. The increased winter rainfall has buttressed the UK's resilience to drought (through both enhanced reservoir and aquifer replenishment and increased baseflow support to spring-fed streams and rivers). Spate conditions have tended to be more frequent but there is, as yet, no strong evidence of a long term increase in flood magnitude. An important factor here is that snowmelt and frozen ground – important exacerbating factors in many major historical floods – are considerably less influential than they were prior to the 1970s. In summary, the enhanced variability of the recent past has important water management implications but, equally, the lack of compelling long term trends in UK flow patterns has clear policy and scientific resonance. In relation to climate change, a greater measure of agreement between (properly moderated)	

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						observational evidence and existing climate change scenarios will a necessary precursor for water policy and managements initiatives to address vulnerabilities associated with projected flood and drought episodes in a warmer world. REFRENCES Black, A.R. and Burns, J.C. (2002) Re-assessing the flood risk in Scotland. Sci. Total Envir., 294(1-3), 169-184. Environment Agency, 2004. Reconstructed river flow series from 1860s to present. Science Report SC040052/SR Fowler, H.J. & Kilsby, C.G., 2003. A Regional Frequency Analysis of United Kingdom extreme rainfall from 1961 to 2000. International Journal of Climatology, 23, 1313 - 1334. Gillett, N. P., Graf, H. F. and Osborn, T. J. 2002. Climate change and the North Atlantic Oscillation. In: Hurrell, J. W., Kushnir, Y., Otterson, G. and Visbeck, M. (eds), The North Atlantic Oscillation - Climatic significance and environmental impact, AGU Monograph Series, AGU. Hannaford, J and Marsh, T.J. 2006. An assessment of runoff and low flow trends in a network of undisturbed catchments. Accepted in International Journal of Climatology September 2005. Hisdal, H., Stahl, K., Talllaksen, L.M. and Demuth, S., 2001. Have streamflow droughts in Europe become more severe or frequent? International Journal of Climatology, 21: 317-333. Jones, P.D. and Conway, D., 1997. Precipitation in the British Isles: An analysis of area-average data up to 1995. International Journal of Climatology, 17: 427 - 438. Jones, P.D. and Lister, D.H., 1998. Riverflow reconstructions for 15 catchments over England and Wales and an assessment of hydrologic drought since 1865. International Journal of Climatology, 18: 999-1013. CEH and UKMO, 2001. To what extent can the October/November 2000 floods be attributed to climate change? Defra FD2304 Technical Report, CEH Wallingford and the Met Office, 116 pp. Mayes, J., 1996. Spatial and temporal fluctuations of monthly rainfall in the British Isles and variations in the mid-latitude Westerly circulation. International Journal of Climatology, 16: 585-596. Osborn, T.J., Hulme, M., Jones, P.D., Basnett, T.A., 2000. Observed trends in the daily intensity of United Kingdom precipitation. International Journal of Climatology, 20(4): 347-364. Robson, A.J., Jones, T.K., Reed, D.W and Bayliss, A.C., 1998. A study of national trend and variation in UK floods. International Journal of Climatology, 18: 165-	

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						182. Robson, A.J., 2002. Evidence for trends in UK flooding. Philosophical Transactions of the Royal Society London A, 360: 1327-1343. Shorthouse, C. A. and. Arnell, N.W. 1997. Spatial and temporal variability on European river flows and the North Atlantic Oscillation. FRIEND '97-Regional Hydrology:Concepts and Models for Sustainable Water Resource Management (Proceedings of the Psotojna, Slovenia, Conference, Sep-Oct 1997), IAHS. Publ. no.246. Werritty, A. (2002). Living with uncertainty: climate change, river flows and water resource management in Scotland. Sci. Tot. Envir.., 294(1-3): 29-40. (Nick Reynard, Centre for Ecology and Hydrology)	
3-413	A	14	33	17	20	Section 3.2.5: The decline in monitoring activity across large parts of the globe over the last 20 years, and the limited number of papers which focus on observed regime change in the peer-reviewed literature makes this a challenging section to draft. But even accepting its early draft status, it is very disappointing. A clearer distinction between both rainfall and river flow trends and observed and modeled evidence for trends in flood magnitude/frequency would make for improved clarity. The absence of any figures illustrating long term trends is telling – particularly given the obvious inadequacy of Table 3.1. The most damaging weakness is the selective use of material and quotations from the featured papers. The caution of the authors' conclusions is often not captured and, in some cases, the sense of their argument is misrepresented. The section would also benefit from some restructuring so that individual paragraphs had tighter themes (e.g. climate change impacts on regimes and seasonality, the role of evaporation in influencing flood risk, snowmelt and ice-jam floods, possible changes in urban flood risk). This would help to ensure that much of the draft doesn't read like a catalogue of recent major flood events. (Nick Reynard, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-414	A	14	33	17	20	Section 3.2.5 needs to establish the difference between increased flood damage and vulnerability and increased flood frequency. The two become confused in places, with the increased costs of damage being used as evidence for increased frequency and/or magnitude of floods. (Nick Reynard, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-415	A	14	33	15	1	I am very interested to see how the authors "flesh" out Table 3.1and from what sources they tap the data. I hope that drought will be well reflected. For example, CRED (Center for the Epidemiology of Disaster Natural Disasters Database--1973-	Material removed from Chapter 3

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						2004) in Belgium, Munich-RE of Germany as well as FEMA (USA, 1995) and NCDC (National Climatic Data Center--NOAA) in Asheville, NC, U.S.A. maintain databases and statistics dealing with drought and its impacts. Specifically though, I would like to see a better reference(s) for the statement made in Lines 40-41 about "droughts and floods becoming more abundant and more destructive than ever in many regions of the globe." Maybe some of the suggested sources above would fill this need? (Mark Svoboda, National Drought Mitigation Center)	
3-416	A	14	33			Why have floods and droughts been combined in one section? If treated as part of a continuum or as "extreme events" this is reasonable, but the discussion follows the classic division. (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-417	A	14	37	14	38	Actually, it is often a particular combination of variables that can generate an extreme event, even if no one single variable takes on extreme values. This is particularly true of floods caused by river ice jams, whose occurrence depends on both current and antecedent conditions. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Material removed from Chapter 3
3-418	A	14	40	14	41	The first sentence of this para does not get overwhelming support by the information in this table. This seems based on a handful of anecdotes. It also includes the Sahel, whose current drought is not unprecedented (Nicholson 2001, Verschuren et al. 2000) -- which ought to be noted in the text. . I would also note the following quote from Kundzewicz (2004) who analyzed 195 long time series for annual max flows from around the world: "The analysis ... does not support the hypothesis of general growth of flood flows. Even if 27 cases of strong, statistically significant increase have been identified... there are 31 decreases as well, and most (137) time series do not show any significant changes. Some regional patterns have been observed. However, a caution is needed, that in case of strong natural variability, a weak trend, even if it exists, cannot be detected by statistical testing." Moreover, it is imconsistent with p. 16, lines 9-10. [Refs: Nicholson, S.E. 2001. Climatic and environmental change in Africa during the last two centuries. Climate Research 17: 123-144; Verschuren, D., Laird, K.R. and Cumming, B.F. 2000. Rainfall and drought in equatorial east Africa during the past 1,100 years. Nature 403: 410-414.] (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Material removed from Chapter 3
3-419	A	14	40	40	44	it is needed to give the time period of observed recent extreme hydrological events in order to show that droughts and floods have become more abundant and more destructive than ever in many regions of the globe and to give the principle or	Material removed from Chapter 3

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						guidance in distingushing the degree of current vulnerability, such as low, medium and high in table 3.1 (Chunzhen Liu, Water Information Center,MWR)	
3-420	A	14	40	14	41	'Recent extreme hydrological events (droughts and floods) have become more abundant and more destructive' THIS IS NOT TRUE. See Svensson et al., 20005; Mudelsee et al., 2003; Kundzewicz et al., 2005; Lindstrom & Bergstrom, 2004, Hisdal et al., 2201, Naulet et al., 2005; Llasat et al, 2005; Robson et al, 1998, Robson, 2002 that contradict evidence of trends (no trend, or not significant), or Mackercah & Henderson, 2003; Adamovski & Bocci, that mention trends in opposite direction. (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-421	A	14	40			Where is the evidence that 'recent extreme events have become more abundant'? (More destructive would be OK - for all sorts of reasons unrelated to climate change). No references are given and Table 3.1 simply underlines the difficulty of buttressing such a sweeping proposition. (Nick Reynard, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-422	A	14	41	14	48	Table referred to in text (line 41) and table heading do not seem to point to the same thing (Nick van de Giesen, Delft University of Technology)	Material removed from Chapter 3
3-423	A	14	45	15	22	Table 3.1 deserves a bit more detils. I am sure that data available from other sources (for example: Dartmouth Flood Observatory http://www.dartmouth.edu/~floods/index.html contains a fairly completed database of floods around the world) should be used to complete the presentation. I would also suggest that discussion includes also what are the impacts that are observed throught he current observation sof extreme events. Certain trends are already visible and indicative of direction of change. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Material removed from Chapter 3
3-424	A	14	47			Table 3.1 Instead of Prague and Dresden in Country, Region column, in the first line (after the header) it would be feasible to refer to Labe/Elbe and Danube basins ,2002 (the latter one is added due to the fact that the same rainfall sequence caused extensive demage and historical flood crests in neighbouring regions on the tributaries of the Danube and certain sections of the main river itself). In the column "Impact" 20 million euros should read billion or thousand million. (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Material removed from Chapter 3
3-425	A	14	47			Table 3.1 add a new item: Country or region: Tisza basin 1998 - 2001 Type of	Material removed from Chapter 3

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						extreme event: sequence of floods (rain, and rain on snow events) Hydrological aspects: four consequitive events where peak levels exceeded all on record "Impact": inundation of around hundred small towns and villages in Ukraine , Rumania and Hungary; Current Vulnerability: Low .(Balint et al, 2006) (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	
3-426	A	14	47			Table 3.1 – Flood in the City of Santa Fe (Argentina) April 2003, combination of river flood and precipitation extreme event: Loss of lives, injuries, psychological damages and important material losses. Drought in the Chaco Province: rain below average in a dry/arid region, for months. Impacts on humans, cattle and natural systems (2004/2005). Avalanches and floods in Central America and Southern Mexico – floods and heavy precipitation due to Hurricane Stan (2005). Severe losses of hundreds of lives, property, infrastructure, etc. (Osvaldo Canziani, IPCC)	Material removed from Chapter 3
3-427	A	14	47	15	1	Table 3.1 The National Drought Mitigation Center, USA, can help provide information on recent drought events. For example, the recent drought in the western United States has been one of the worst on record, affecting regional aquifer levels and streamflows (i.e., the Colorado River). Colorado recieved the lowest rainfall on record in 2002 and streamflows were the lowest in 300-500 years. See recent work by the USGS, and Cook and Woodhouse. (Cody Knutson, University of Nebraska-Lincoln)	Material removed from Chapter 3
3-428	A	14	47			Table 3.1 is not representative enough. The information used seems to be very heterogeneous (e.g. in the column "Impacts"). Make a better recherché or delete it completely. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Material removed from Chapter 3
3-429	A	14	47			I would like to add to the table 3.1 a line cell1 :North Africa, cell2 : drought, celle3 : rainfall below the average for the normal period 1930-1960, cell4 : natural and human systems, cell5 : high (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Material removed from Chapter 3
3-430	A	14	47			Table 3.1 Could note that although these are case studies they are indicative of events that could become more the norm in the future. (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-431	A	14	48			Table 3.1: It is not evident how this table demonstrates that recent extreme	Material removed from Chapter 3

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						hydrological events have become more abundant and more frequent. Perhaps this will be rectified when the Table is "completed and updated", as indicated in row 48. Also, in the second row of Table 3.1, should the cost be in billions rather than millions ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-432	A	14	48			Table 3.1 is not convincing. Are we to believe that these extreme events are evidence of a changed pattern? Why? (Rob de Loë, University of Guelph)	Material removed from Chapter 3
3-433	A	14		17		Section 3.2.5,: This entire section is internally inconsistent and implies/ misconstrues that the general growth in flood losses in recent years is due to an increase in flood frequency and severity as a result of climatic change. It is particularly troubling in light of the fact that there have been no observed systematic increases in floods (damaging or otherwise). I say that it "implies/misconstrues" because of the wording of the text. Consider, for example, lines 40-44, page 14, and Table 3.1. However, recent extreme hydrological events -- droughts and floods -- have become more abundant and more destructive than ever in many regions of the globe (Table 3.1). The immediate question emerges as to the extent to which a sensible rise in hazard of droughts and floods can be linked to global changes, and in particular - climate variability and change, in the light of observations made so far. Unfortunately, nothing in Table 3.1 supports the contention that extremes have become more abundant because the table simply lists some recent floods and droughts without ANY information as to how these events represent a change in frequency and severity from past times. Simply listing the costs of recent floods and droughts provides no relevant information to the question of flood and drought impacts of climatic change when it is absolutely impossible to even loosely associate any of those events with climate change. The table should be deleted -- it is irrelevant. Such a table could be constructed for any historical 10, 30, or 50+ year period throughout history and it would look the same, including the loses if adjusted for inflation (Harry F Lins, World Climate Programme-Water)	Material removed from Chapter 3
3-434	A	15	0			Table 3.1. Very incomplete and misleading. Must include significance of trends, method to define trends, and record lenghts. Col 3; Row3 'Very rare frequency (0.5-1%). Not sure of the rarity of 100-year event (size of design floods for flood protection). Generally speaking it is not because a flood occured recently that it is a sign of climate change. A lot of major floods occured in the past (See e.g. Llasat et al., 2005 in Spain, and Naulet et al., 2005 in France) (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3

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3-435	A	15	0			Please note that Floods depend on at least the following: 1) Rain amount and time. 2) presence or not of snow, 3) condition of streams, rivers, ice dams, levels, 4) ground cover, soils, vegetation (deforestation), infiltration, 5) soil wetness, 6) topography, slopes, drainage, 7) human structures, levees, dams, reservoirs. (Martin Savard, Geological Survey of Canada)	Material removed from Chapter 3
3-436	A	15	1	15	35	There is considerable documentation of major flood events over the last decade but little evidence that they constitute part of any continuing trend. Increases in damage, insurances payouts and fatalities do not address the core issue of whether climate change is increasing flood risk. Where trend issues are discussed or implied, they mostly do not stand critical evaluation. For example: I. The 2002 flood on the Vltava was indeed the highest in a 175-year record. But no mention is made of the long term downward trend in annual peak flows (very probably reflecting the growth in flood storage reservoirs). II. Although not made clear in the text, the Elbe flood was generated by the same storm that caused the Vltava flood. It resulted in the highest flow on the Elbe since 1845. But, again, there is no hint of an upward trend in annual maxima (see lines 2&3 on page 16). III. The evidence from Scotland is important but needs to be treated with caution. Most Scottish flow records on major rivers begin between the mid-1950s and mid-1970s, generally a quiescent period for flood events. There is certainly a notable contrast between flows pre- and post-1980 but a broader historical perspective is needed to assess long term trends. All the 'new maxima' referred to in the Black and Burns paper (see line 17) were registered in the 1989-95 period; the wettest 6-year sequence on record for Scotland). It is unsurprising that significant trends can be identified using records ending in the late 1990s. A quick scan of recent peaks suggest that only around three of the 16 rivers have eclipsed previous maxima over the last decade. IV. A significant proportion of the evidence derives from Russia. Stalin bequeathed the USSR an impressive network of pristine catchments but there must be suspicion regarding gauging station performance post-1989, and hence the homogeneity of the high flow series. In any case there is no real attempt to place the featured recent extreme events in any historical context or to address the trends issue. V. An 'increase in the frequency of severe floods in 16 extra-tropical basins' (Milly et al, 2002) is described by the authors as tentative and obviously invites further critical review because no significant trends were found for floods having return periods lower than the target 100-yr events. It is notable also that the majority of rivers used in this study were Russian, and that no 100-yr event appears to have	Material removed from Chapter 3

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						been identified for any of the rivers over the 1865-1920 period (there may be hydrometric explanations for this). VI. The reference (Page 16, line 1) flow maxima for European rivers being recorded more often in the 1981-2000 period than in the previous 20 years is correct. But no mention is then made of the conclusion in the paper (Kundzewicz, 2004) that 'a general and coherent increase in high river flows has not been detected'. Svensson et al (2004) provides support for this latter view. The global study by Kundzewicz et al (2005) is mentioned (lines 32-34) and Kundzewicz's work (with collaborators) pervades the floods chapter, but without the coherence of the original papers. His conclusions are picked up in the summary (lines 9-10) but the singular importance of his global study (accepting that it wasn't able to distinguish pristine from 'affected' river basins) is not given due weight and, crucially, is ignored in the Executive Summary. (Nick Reynard, Centre for Ecology and Hydrology)	
3-437	A	15	1			Table 3.1: list incomplete, fragmentary, no link to climate change. Need to discuss factors in floods, see below. What are references? (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-438	A	15	1	15	1	Table:In Finnish Lapland 3 new records of max discharge at spring 1992 city of Ivalo and spring 2004 city of Ivalo(small) and Kittilä (damage 5 milj €) floods induced by snowmelt. Caused by record snow storage. Current vulnerability moderate. (Bertel Vehviläinen, Finnish Environment Institute)	Material removed from Chapter 3
3-439	A	15	3	15	27	Obviously the author can not decide itself between his criteria for extreme floods: extreme with regard of damages or extreme from the climatological point of view. Here the second aspects would be more interesting. That this difference is important shows the Dresden example at Line 12 - 14. The highest water level for more than seven centuries was not caused by the highest discharge within this time span, but it resulted from a poor maintenance of the hydraulic capacity of the river bed. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Material removed from Chapter 3
3-440	A	15	3	15	27	Fragmentary. Floods occur, what is the change? What is the cause? (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-441	A	15	3	15	12	More frequent flooding: Does the literature really prove increased flooding due to climate change (and not due to canalization, poor reservoir management, etc)? If so, this should really be given a very prominent place.	Material removed from Chapter 3

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						(Nick van de Giesen, Delft University of Technology)	
3-442	A	15	7	15	8	"and a part of the losses is linked to climatic factors": The basis of this statement is unclear at this point in the text. I suppose the author meant to demonstrate it via the several examples that follow (lines 9-27). However, these examples do not necessarily "prove" that climate change has an effect on the increased magnitude of the cited disasters. Higher peak flows and stages could well be caused by urbanization, elimination of natural storage by dykes, etc. More convincing would be such hydrological evidence as rainfall intensity and volume, soil conditions, snowpack, melt intensity, etc. If this type of work has actually been done in some cases, it should be cited here. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Material removed from Chapter 3
3-443	A	15	7		8	I don't disagree with the point that increases in population and wealth account for some of the increase in damage, while climate factors account for others. Nonetheless, the point demands better support and evidence. The evidence cited could just as easily support the "more damage due to more development and wealth" argument. (Rob de Loë, University of Guelph)	Material removed from Chapter 3
3-444	A	15	7	15	8	Socio-economic factors do explain the growth in property losses due to floods for the United States. U.S. indicates that, indeed losses have increased for floods and hurricanes but because there is now more property at risk (because the population has increased and it wealthier). If the increases in property at risk is accounted for, there is no significant trend for either hurricanes or floods. [I am not aware of property loss studies for other types of events]. References: [1] Goklany (2000), [2] R.A. Pielke, Jr. and C.W. Landsea, "Normalized hurricane damage in the United States: 1925-1995," Weather and Forecasting 13: 621-631 (1998), [3] Mary W. Downton, J. Zoe Barnard Miller, and Roger A. Pielke Jr. 2005 Reanalysis of U.S. National Weather Service Flood Loss Database. Natural Hazards Review. February 2005: 13-22. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Material removed from Chapter 3
3-445	A	15	8			Note that recent attribution studies focus on the increased risk of extremes due to anthropogenic emissions. See for example: Stott, P.A., Stone, D.A. and Allen, M.R. 2004. Human contribution to the European heatwave of 2003. Nature, 432, 610-614. (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-446	A	15	9	15	14	This fails to account for mitigation by humans. (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-447	A	15	14	15	14	BfG (The German Federal Institute of Hydrology, 2002) measured the peak	Material removed from Chapter 3

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						discharge with 4680 m³/s; this is a return interval about 150 years (see: DKKV: Flood Risk Reduction Publication 29e (February 2004); reasons: "drastically reduced flood water transfer potential in the urban area region of Dresden", see also: Umweltamt Dresden (2004): Analyse und Schlussfolgerungen für den Hochwasserschutz in Dresden. In: Flutkatastrophe 2002: Das Augusthochwasser in Dresden. Landeshauptstadt Dresden, Umweltamt, CD-ROM: "Das Augusthochwasser 2002 hat gnadenlos die Schwachstellen im Hochwasserschutz, im Unterhaltungszustand der Gewässer und in der Organisation der Hochwasserabwehr gezeigt" (page 3). (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	
3-448	A	15	17			Possibly due to large increases in observed extreme rainfall (two-fold) in the 1990s in Scotland - see Fowler, H.J. and Kilsby, C.G. 2003. Implications of changes in seasonal and annual extreme rainfall. Geophysical Research Letters, 30(13), 1720, doi:10.1029/2003GL017327. Fowler, H.J. and Kilsby, C.G. 2003. A regional frequency analysis of United Kingdom extreme rainfall from 1961 to 2000. International Journal of Climatology, 23(11), 1313-1334. (Hayley Fowler, Newcastle University)	Material removed from Chapter 3
3-449	A	15	17			Black and Burns (2001) ref incomplete (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-450	A	15	21			I would insert the following at the end of line 21: "According to the EM-DAT database -- which is incomplete, and the further back one goes, the more incomplete it is likely to be -- aggregate deaths and death rates worldwide due to floods are substantially lower today than they were pre-1950. The average number of deaths per year from floods dropped from 436,000 during the 1930s to 5,000 from 2000-2004, while death rates over this period dropped from 204 per million to around 1 per million {Goklany, personal communication.] Similarly, deaths and death rates in the US are lower today than they were a few decades ago. These declines probably are owed more to socioeconomic factors which enhance a society's adaptive capacity than to any climatic changes [Goklany 2000, 2005b]. " (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Material removed from Chapter 3
3-451	A	15	21			This is wrong. Hydrological droughts can lag meteorological droughts by years and may continue long after rains return. This depends on intensity, runoff, etc as well as amount. (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-452	A	15	25	15	27	Sentence regarding the floods between 1953 and 2000 and 33 million people being affected is no doubt true but its link to climate change was not made clear.	Material removed from Chapter 3

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						(Harvey Hill, Prairie Farm Rehabilitation Administration)	
3-453	A	15	26			On average 33 million persons per year or in total between 1953-2000 (than it would not be an average). (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Material removed from Chapter 3
3-454	A	15	27			I propose to add "The floods from November 10, 2001 in Algiers caused the death of almost 1000 people and the damage cost exceeded one billion dollar" (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Material removed from Chapter 3
3-455	A	15	28			New results fo the Rhine river are missing (Lit. Wetzel, Volkhard: Climate variability and impact on hydrological extremes - the Elbe flood 2002 in comparison to recent flood events on the rivers Odra and Rhine - impact of climate variability on low flows. - In: Proceedings of the 2nd Workshop Impact, Biovailability and Assessment of Pollutants in Sediments and Dredged Materials under Extreme Hydrological Conditions, 3 - 5 April 2003 / SedNet. - Berlin, 2003, - S. 23 - 26; Engel, Heinz: The development of floods in navigable rivers in Germany. - Aus: Hafenbautechnische Gesellschaft, HTG-Kongress 2003, Stuttgart, 17. - 20.9.2003, S. 151 - 160; Krahe, Peter: Climate change and its impact on hydrology and water resources in the Rhine basin) - In: Hydrologie und Wasserbewirtschaftung. - 47 (2003) H. 5, S. 208 (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Material removed from Chapter 3
3-456	A	15	29	16	14	long-term fluctuations in the frequency of flooding have been identified in the last five centuries in Europe too (see: Ch. Pfister: A calendar of the last 500 years. In: OcCC (2003): Organe consultatif sur les changements climatiques/Beratendes Organ für Fragen der Klimaänderung: Extremereignisse und Klimaänderung. Bern, September 2003, pp. 21-24) (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	Material removed from Chapter 3
3-457	A	15	29	15	35	This seems to be a very relevant and important paragraph. Put this higher up in text (and leave out some of the remaining lesser clear, more speculative texts. (Nick van de Giesen, Delft University of Technology)	Material removed from Chapter 3
3-458	A	15	30	15	35	Needs revision see Dai et al 2004. (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-459	A	15	33	15	34	There are other examples of studies that have specifically tested for increases in floods or highest flow quantiles that have not observed them. A review of the empirical evidence to date does not consistently support an increase in the highest flow quantiles in the United States (Douglas et al., 2000; McCabe and Wolock, 2002; Vogel et al., 2002), Canada (Zhang et al., 2001), Scandinavia (Lindstrom and	Material removed from Chapter 3

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						Bergstrom, 2004; Hyvarinen, 2003). Douglas, E.M., R.M. Vogel, and C.N. Kroll. 2000. Trends in floods and low flows in the United States: Impact of spatial correlation. Journal of Hydrology 240:90-105. Hyvarinen, V., 2003. Trends and characteristics of hydrological time series in Finland. Nordic Hydrology 34, 71-90. Lindstrom, G., Bergstrom, S., 2004. Runoff trends in Sweden 1807-2002. Hydrol. Sci. J. 49, 69-83. McCabe, G.J., Wolock, D.M., 2002. A step increase in streamflow in the conterminous United States. Geophys. Res. Lett. 29(24), 2185, doi:10.1029/2002GL015999,2002. 29, 38-1 to 38-4. Vogel, R., Zafirakou-Koulouris, A., Matalas, N.C., 2002. Frequency of record-breaking floods in the United States. Water Resour. Res. 37, 1723-1731. Zhang, X., Harvey, K.D., Hogg, W.D., Yuzyk, T.R., 2001. Trends in Canadian stream flow. Wat. Resour. Res. 37, 987-998. (Thomas Huntington, U.S. Geological Survey)	
3-460	A	15	35	16	2	Misleading interpretation. The 70s were dry and the 80s wet in Europe (e.g. Robson 2002), so it is expected naturally to have more extreme events during the wet period. If longer series were looked at, it is not garanteed that such significant trend would be found. Importance of long records/ misleading results from short records/ influence of period of record is highlighted by many authors (e.g. Robson et al., 1998 and Robson 2002 in the UK; Lindstrom & Bergstrom, 2001 in Scandinavia). Paragraph needs clarification (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-461	A	15	35	16	2	This effect is not surprising as the probability that an extreme flood event depend on the length of observation. A mathematical description of this effect is given by Vogel et al. WRR,Vol. 37 No.6 in 2001 (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Material removed from Chapter 3
3-462	A	16	0	17		This section is poor and not consistent with earlier section. (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-463	A	16	1	16	7	Some of the time periods referred to as reflecting increased flooding are relatively short have they sufficiently ruled out decadal variability as a potential cause? (Harvey Hill, Prairie Farm Rehabilitation Administration)	Material removed from Chapter 3
3-464	A	16	2			Add reference: Tu et al. (2005) found that the increase in flood peaks in the Meuse and its tributaries appears to be affected by climatic variability, particularly by the	Material removed from Chapter 3

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						increased antecedent precipitation depths. Tu, M., Hall, M.J., Laat, P.J.M. de and Wit, M.J.M. de, 2005. Extreme floods in the Meuse river over the past century: aggravated by land-use changes? Physics and Chemistry of the Earth, Parts A/B/C 30(4-5): 267-276 (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	
3-465	A	16	7			Some comment on changes in joint probabilities is also merited. See for example: Sivapalan, M., Bloschl, G. Metrz, R. and Gutknecht, D. 2005. Linking flood-frequency to long-term water balance: Incorporating effects of seasonality. Water Resources Research, 41, W06012, DOI 10.1029/2004WR003439. (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-466	A	16	8			Time series analysis on daily data basis in Baden-Württemberg/Germany (Lit.: Luft, G., Straub, H. & H. J. Vieser: Trends der mittleren und extremen Abflüsse in Baden-Württemberg (Trends in mean and extreme streamflower in Baden-Württemberg/Germany) Hydrologie u. Wasserbewirtschaftung 46 (2002), H. 5, p. 208 - 219) (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Material removed from Chapter 3
3-467	A	16	9	16	14	Good, "value-adding" paragraph. The reader is provided with a concise summary of what the previously-enumerated occurrences imply (and do not imply), by referring to the attendant physical mechanisms. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Material removed from Chapter 3
3-468	A	16	9	16	10	For example, the second key finding states Floods and droughts have become more severe in some regions are very likely to increase in severity still further. Curiously, however, it is difficult to infer this finding from a careful reading of the reports cited in Section 3.2.5 on Floods, droughts and their impacts. The text in Section 3.2.5 clearly states: Summarizing, no general and consistent change is visible in observational records - globally, no uniform increasing trend in flood flows has been detected (p. 16, lines 9-10) (Harry F Lins, World Climate Programme-Water)	Material removed from Chapter 3
3-469	A	16	9	16	14	Should insist more on sentence 'No general consistent change is visible in observational records' This is the only evidence so far - MUST APPEAR IN EXECUTIVE SUMMARY instead of anecdotal evidence of some short-term trends. (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-470	A	16	9	16	14	This summary paragraph in particular is not reflected in the Executive Summary. (Nick Reynard, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-471	A	16	11	16	13	It also contains a purely gratuitous appeal to an observed increase in intense precipitation (i.e., Significantly more intense precipitation has been already	Material removed from Chapter 3

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						observed in many, but not all areas, hence magnitudes of rainfall-caused river flood may increase with warming [page16, lines 11-13]); but this statement assumes that qualitative modifier "intense" in front of precipitation makes it synonymous with flooding. In fact, it is not and should not be so misconstrued. Nearly all published reports of increases in higher intensity precipitation are referring to 50 mm per day events. Such intensities are not flood generators. To increase flooding, there need to be precipitation increases in 100-200 mm per day rates or 200-400 mm totals over 2-4 day periods. Significantly, upward trends in these very high rainfall rates (i.e., the true tails of the precipitation distribution) have not been reported in the literature. The same can be said with respect to droughts. There have been no published reports documenting that drought frequency and/or severity have been increasing. Indeed, every published study of trends in low streamflows has found an overwhelming predominance of increasing trends, worldwide. How then can it be inferred in the Executive Summary that floods and droughts have become more severe? This "key emerging finding" is not supportable on the basis of the published literature and really must be changed to reflect the facts. I suggest that it be rewritten as follows: No significant change has been observed in the frequency or severity of floods and droughts. Although increases in "intense" and "extreme" precipitation have been reported in a number of regions, there is no evidence of a corresponding increase in the frequency and/or severity of floods. This is likely due to the fact that the reported precipitation increases have been primarily in intensities in the range of 50-75 mm per day, which are generally insufficient to produce flooding in most instances. Moreover, in many regions the precipitation increases have occurred during the season of low annual streamflows, which has produced discharge increases in the lower streamflow categories and diminished hydrologic drought. The first key emerging finding states: Climate-driven changes in river flow and other components of the water cycle have already been observed. Even stronger changes are projected. By inserting the word "already," the implication is clearly being made that trends are occurring that wouldn't otherwise be and that they're being caused by something other than natural system variability. Interestingly, if the word "already" is removed from the sentence you're left with a statement that obviates the need to include it as a key emerging finding. In reality, no matter what time period you choose, 1850-1920, 1925-1960, 1930-2000, 1950-2005, it doesn't matter, the statement "climate-driven changes in river flow and other components of the water cycle have been observed" can honestly and accurately be made. Such changes in the hydrologic system were well documented and described by Hurst	

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						more than 50 years ago as long-term persistence (Hurst, 1951). To imply that the changes observed over the past 30-, 40-, or 50-years are attributable to something other than the long-term persistence that is known to characterize hydro-climatological processes is, at best, speculative. There is absolutely nothing that is "key" or "emerging" about the trends that are being observed in hydrologic cycle variables; it is simply the way the system works (see Cohn and Lins, in press). I strongly recommend that this item be dropped from the Executive Summary. (Harry F Lins, World Climate Programme-Water)	
3-472	A	16	11	16	12	Not sure the statement is true. Delete, or put peer-reviewed reference of analysis on LONG-DURATION series (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-473	A	16	12	16	12	missing references (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Material removed from Chapter 3
3-474	A	16	12			N-day rainfall totals are also increasing flood risk in some regions. See for example: Fowler, H.J. and Kilsby, C.G. 2003. A regional frequency analysis of United Kingdom extreme rainfall from 1961 to 2000. International Journal of Climatology, 23, 1313-1334. (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-475	A	16	13	16	13	typo: … warming. Floods decrease (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Material removed from Chapter 3
3-476	A	16	13			Flood floods…..remove flood (Batima Punsalmaa, Institute of meteorology and Hydrology)	Material removed from Chapter 3
3-477	A	16	13	16	14	In southern Finland winter runoff increases considerably due to increase in snowmelt and rainfall and spring floods decrease. In northern Finland spring floods increase at first due to increase in snowfall but later with continuous warming spring flood decrease is valid in northern Finland. Hyvvärinen; V. 2003. Trends and Charateristics of Hydrological Time Series in Finland. Nordic Hydrology, 34(1/2),2003, 71-90; Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095 (Bertel Vehviläinen, Finnish Environment Institute)	Material removed from Chapter 3
3-478	A	16	14			Add here "resulting from higher winter temperature". (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Material removed from Chapter 3
3-479	A	16	16	16	19	Increases in summer drying needs reference – for example Dai et al. 2004 and Menon (2002). Also there should be refs for the second sentence of this paragraph	Material removed from Chapter 3

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						regarding relation between snow and summer flow see perhaps Stewart et al 2005 and refs therein. Dai, A., Trenberth, K.E., Qian, T., 2004. A Global dataset of Palmer drought severity index for 1870–2002: relationship with soil moisture and effects of surface warming. J. Hydrometeor. 5, 1117–1130. Menon, S., Hansen, J.E., Nazarenko, L., Luo, Y., 2002. Climate effects of black carbon aerosols in China and India. Science 297, 2250-2253. Stewart, I.T., D.R. Cayan, and M.D. Dettinger. 2005. Changes toward earlier streamflow timing across western North America. Journal of Climate 18:1136-1155. (Thomas Huntington, U.S. Geological Survey)	
3-480	A	16	16	16	20	Must add reference - Are summers really drier than before? (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-481	A	16	16	16	19	Add reference (Paolo Reggiani, Delft Hydraulics)	Material removed from Chapter 3
3-482	A	16	18	16	19	Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095: The annual variation of model specific soil moisture tends to increase. Autumns and winters become wetter and summers drier. (Bertel Vehviläinen, Finnish Environment Institute)	Material removed from Chapter 3
3-483	A	16	18	16	19	The annual variation of model specific soil moisture tends to increase. Autumns and winters become wetter and summers drier. This may also lead to an increased demand of irrigation in agricul-ture. (Bertel Vehviläinen, Finnish Environment Institute)	Material removed from Chapter 3
3-484	A	16	21	17	14	see: Deutscher Wetterdienst (2004): Klimastatusbericht 2003, Offenbach. esp.: Beck, Ch. et al.: Die Trockenperiode des Jahres 2003 in Deutschland im Kontext langzeitlicher Niederschlagsvariabilität (pp 142-151); BfG (2004): Das Niedrigwasser 2003 in Deutschlands Stromgebieten. 16 pages. (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	Material removed from Chapter 3
3-485	A	16	21	17	20	These paragraphs relate mostly to droughts. May be it is better to write about impacts of drought on water resources for example: changes in levels of rivers, lakes, and groundwater table (Batima Punsalmaa, Institute of meteorology and Hydrology)	Material removed from Chapter 3
3-486	A	16	21	16	28	I suggest to shorten this paragraph, as this drought classification is common knowledge. (Paolo Reggiani, Delft Hydraulics)	Material removed from Chapter 3

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3-487	A	16	21	17	20	From the drought perspective, a glaring problem is impact collection, both qualitative and quantitative. We just don't have much of a baseline for droughts. In the paragraph beginning with Line 16, environmental would seems to be a valid sector and under the health wording of Line 19 I would add respiratory in parenthesis with stress, epidemics, diarrhea, etc. Back to the baseline thought, for drought in particular, our impact collection has been quite poor and is often associated with heat waves, famine, desertification, etc. We lack a true systematic impact collection network for this hazard. I truly feel we are much more vulnerable to drought and other hazards, but evidence supporting this claim as far as impacts are concerned are lacking given the fact that it is hard to compare them and their impacts, with or without data. It is a spatial and temporal issue. (Mark Svoboda, National Drought Mitigation Center)	Material removed from Chapter 3
3-488	A	16	30	16	35	'Large impact droughts have recently occurred in several regions' Not usefull statement: where? Since when? In the past, some large-impacts droughts did occur (e.g. 1976 in Europe). Again, occurence of recent extreme events is not a proof of a change in climate. Climate is naturally variable, and that must not be forgotten (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-489	A	16	30	16	35	And also in other places: West Africa is more than the Sahel and recent good work on climate (impact) does exist and should be included (see further work by Mahe and work by the German global change research projects "GLOWA Volta" and "Impetus". (Nick van de Giesen, Delft University of Technology)	Material removed from Chapter 3
3-490	A	16	33			I propose to add "Sahel and North Africa" (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Material removed from Chapter 3
3-491	A	16	38			'… droughts and desertification have ALWAYS been present in Africa' This is not true for the whole of Africa (plenty of regions are tropical humid). Also, not sure that Sahara has not been wetter in the long past - Carefull in statements! (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-492	A	16	40	16	48	The drought period in summer 2003 in Europe was no "long-lasting" event in comparison with historical droughts but it was characterized by extreme high temperatures. Proposal: cancel "long-lasting" (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Material removed from Chapter 3
3-493	A	16	40			what climate change? (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-494	A	16	41			What type of drought is discussed here? (Andreas Schumann, Institute of Hydrology, Water Resources Management and	Material removed from Chapter 3

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						Environmental Engineering)	
3-495	A	16	41			same as above " Sahel and North Africa" (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Material removed from Chapter 3
3-496	A	16	42			same as above " Sahel and North Africa" (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Material removed from Chapter 3
3-497	A	16	46	17	3	You could include an example from the western United States from 1999-2004. (Cody Knutson, University of Nebraska-Lincoln)	Material removed from Chapter 3
3-498	A	16	46	16	48	The drought period in summer 2003 in Europe was no "long-lasting" event in comparison with historical droughts, but it was characterized by extreme high temperatures. Proposal: cancel "long-lasting" (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Material removed from Chapter 3
3-499	A	16	47	17	3	Comment "Please, include here the reference Ciais et al. 2005. Europe-wide reduction in primary productivity caused by the heat and drought in 2003. Nature, vol 437, pp. 529-533." (Pirkko Kortelainen, Finnish Environment Institute)	Material removed from Chapter 3
3-500	A	16	50			I proposed to add "Southern Europe and North Africa" (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	Material removed from Chapter 3
3-501	A	17	0			Authors could use Gleick's biennial report (a widely cited and important "gray" resource) in the section about global water use trends. It has an excellent pedigree and covers the material well. Gleick, P. 2004. The World's Water: The Biennial Report on Freshwater Resources 2004-2005. Washington: Island Press. (Rob de Loë, University of Guelph)	Material removed from Chapter 3
3-502	A	17	0			A lot of the material in Section 3 is ground that has been covered well in other recent documents. Is it necessary to go into that much detail (especially when the added value is not immediately clear, and the literature review sometimes seems a bit haphazard [see below])? For example, Kabat and Van Schaik (2003) have recently provided an extensive summary of the state of knowledge regarding climate change and water resources. Their report is "gray" literature, but it's also a major recent report that does a very good job on this topic. Kabat, P. and H. Van Schaik. 2003. Climate Changes the Water Rules. ISBN 90-327-0321-8 Note: on page 22, line 38, there's a reference to Kabat, et al 2003 -- but there's no entry in the reference list. Is this the one I'm referring to? Also, in Box 3.2 on page	Material removed from Chapter 3

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						59 there's a reference to Kabat and Van Schaik (2003); is it this one? (Rob de Loë, University of Guelph)	
3-503	A	17	1			Please rephrase and clarifiy second sentence: "This may reflect conditions to be expected in a greenhouse cliamte"?? Is that what the author mean? (Martin Savard, Geological Survey of Canada)	Material removed from Chapter 3
3-504	A	17	1	17	3	What about floods in Europe in 2002 and 2005? This is too simplistic. (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-505	A	17	3			See comment on changing risk of extremes, as well as Stott et al. (2004) above. (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-506	A	17	4			I would insert the following on line 4: "According to the EM-DAT database, for droughts, average deaths per year worldwide dropped from 472,000 in the 1920s to about 200 in 2000-2004; death rates declined from 235 per million to less than 0.04 per million {Goklany, personal communication.] These declines possibly are owed more to socioeconomic factors which enhance a society's adaptive capacity rather than to climate." (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Material removed from Chapter 3
3-507	A	17	5	17	11	The qualification regarding regional cross-correlation is a very valid point. However, it should be noted that the results of Zhang et al. (2001) did not consider cross-correlation. Therefore, the results should be qualified or results that have considered regional cross-correlation should be referenced here instead. Note that one example of a paper that looks at the same network as Zhang et al. and does consider regional cross-correlation is Burn, D.H. and Hag Elnur, M.A. (2002). "Detection of hydrologic trends and variability", Journal of Hydrology, 255, 107-122. (Donald Burn, University of Waterloo)	Material removed from Chapter 3
3-508	A	17	5	17	14	True statement. Should not be ignored in executive summary (Christel Prudhomme, Centre for Ecology and Hydrology)	Material removed from Chapter 3
3-509	A	17	8	17	14	Please mention the strong human impacts on low flows! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Material removed from Chapter 3
3-510	A	17	9	17	11	The cross-correlation thing is not clear. (Nick van de Giesen, Delft University of Technology)	Material removed from Chapter 3
3-511	A	17	11	17	14	There are several more recent publications that make the case for increases in stream flow in the U.S. especially for increases in lower and intermediate flow quantiles. Mauget, S. 2004. Low frequency streamflow regimes over the central United States: 1939-1998. Climatic Change. 63:121-144.	Material removed from Chapter 3

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						McCabe, G.J., and D.M. Wolock. 2002. A step increase in streamflow in the conterminous United States. Geophys. Res. Lett. 29(24), 2185, doi:10.1029/2002GL015999,2002. 29:38-1 to 38-4. Walter, M.T., Wilks, D.S., Parlange, J.-Y., Schneider, R.L., 2004. Increasing evapotranspiration from the conterminous United States. J. Hydrometeorology 5, 405–408. (Thomas Huntington, U.S. Geological Survey)	
3-512	A	17	12			This is dated material. (Kevin Trenberth, National Center for Atmospheric Research)	Material removed from Chapter 3
3-513	A	17	14			See also: Hisdal, H., Stahl, K., Tallaksen, L.M. and Demuth, S. 2001. Have streamflow droughts in Europe become more severe or frequent? International Journal of Climatology 21, 317-333. (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-514	A	17	14			Note that a recent analysis of low flows in the UK showed no significant trend in spring or summer flows. See: Wade, S., Vidal, J., Dabrowski, C. Young, P. and Romanowicz, R. 2005. Effect of climate change on river flows and groundwater recharge. A practical methodology. Task 7. Trends in UK river flows: 1970 – 2002. UKWIR/ Environment Agency, 61pp. (Robert Wilby, Environment Agency of England and Wales)	Material removed from Chapter 3
3-515	A	17	15	17	15	Add reference: Hisdal et al. (2001) analysed 600 daily streamflow records throughout Europe and conclude that streamflow droughts have not become more severe or frequent. Hisdal, H., Stahl, K., Tallaksen, L.M. and Demuth, S.: 2001, Have streamflow droughts in Europe become more severe or frequent? Int. J. Climatol. 21, 317-333. (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Material removed from Chapter 3
3-516	A	17	16	17	20	see: OcCC (2003) page 7: "The probability and geographical distribution of extreme events will alter gradually with the change in climate. The extent and character of the changes will differ depending on the location and character of the extreme events. It is not at present possible to give a quantitative assessment of these effects." and page 8: "Even in the absence of climate change, there is an evident need for action to provide protection against extreme events owing to the increasing concentration of assets and their higher vulnerability, and the societie´s enhanced need for protection. In recognition of the changing climate, hazard patterns, protection objectives and accepted residual risks should be periodically reviewed and solutions permitting the greatest possible flexibility sought. In the middle term, new assessment and planning methods must be developed that are	Material removed from Chapter 3

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						able to quantify the risks under changing climatic conditions." (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	
3-517	A	17	16	17	20	Move these lines to Page 14 Line 39. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Material removed from Chapter 3
3-518	A	17	23	18	32	This section “water availability and use” misses the opportunity to reference methods to measure soil moisture and to recommend the optimum irrigation strategies to save water, including advice to developing country’s decision makers on technologies to determine the different crops’ water requirements. This is an important reference to improve water use and develop apprpriate IWM strategies. This section should be coordinated with Chapter 5. and the regional chapters.. (Osvaldo Canziani, IPCC)	This is mentioned in section 3.6 on adaptation
3-519	A	17	23			Section 3.2.6. OK - No general comment - Good quality overall (Christel Prudhomme, Centre for Ecology and Hydrology)	o.k.
3-520	A	17	23	18	33	I do agree with the main conclusion that non-climatic drivers do impact water use more than the climatic change. However, combine effect of lets say population growth in some regions and climatic change may in the future change the picture. I would suggest that this section include two more factors: (a) increase in concentration of population in urban areas and climatic impact on these settlements (see level rise and the fact that 80% of large cities are located in the close proximity to the shores); and (b) climatic change impact on water supply for large cities. It is quite obvious that the report has addressed water quality impacts in much more detiled way compared to water quantity impacts. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	One sentence on highly populated coastal areas added at the end of the section.
3-521	A	17	26			Terrestrial ecosystems equally depend on freshwater, which should be clearly stated somewhere in this chapter (potentially with links to Chapter 4). (Dieter Gerten, Potsdam Institute for Climate Impact Research)	The concept of blue and green water will be introduced in section 3.1
3-522	A	17	27			For greater inclusiveness use "freshwater" instead of "instream". (Robert Wilby, Environment Agency of England and Wales)	“instream” replaced by “in-situ” both times. Here, off-site use was intended to be distinguished from on-site use.
3-523	A	17	40	17	41	Runoff generation is not depending mainly from storage capacities in general (e.g. in arid regions it depends mainly on rainfall intensity). (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Second part of sentence removed.
3-524	A	17	42			What means "important"? For whom? (Andreas Schumann, Institute of Hydrology, Water Resources Management and	“for water supply” added

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						Environmental Engineering)	
3-525	A	17	43			basin > basis (Levent Kavvas, University of California, Davis)	Whole sentence removed
3-526	A	17	45			Again, the scope should be wider than rivers. (Robert Wilby, Environment Agency of England and Wales)	It is already as river flow variability also impacts estuarine ecosystems or those in lakes.
3-527	A	18	2	18	9	One should mention here that rainfed agriculture also depends on water, not only irrigated agriculture. Also, a graph from which one can depict current sectoral (and/or regional) patterns of water use would be helpful here. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	See notes to 3-521; no space for such a graph; need that space in 3.4.
3-528	A	18	2			For information on observed climate change impacts on irrigation water withdrawals contact Keith Weatherhead (Cranfield, UK) (Robert Wilby, Environment Agency of England and Wales)	Keith Weatherhead contacted 13/12/2005; said that year to year variability plus agricultural policies prevent to derive climate change impact from historical data on irrigation water use for the UK.
3-529	A	18	5	18	8	It should also be pointed out that large scale irrigation can change local climate by increasing atmospheric water vapor content. (Lenny Bernstein, IPIECA)	Added.
3-530	A	18	5			Irrigation water use also depends on the crops planted and agronomic practices. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Yes, but no space here to discuss this.
3-531	A	18	5	18	8	Poor example. “Water requirement changes with climate” this includes the second effect described on Line 7 as irrigation provides surplus-water. Maybe you should differentiate between "demand" and "supply" side! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Reformulated.
3-532	A	18	5			Irrigation water use is also affected indirectly by climate change by changes in crop type. (Robert Wilby, Environment Agency of England and Wales)	Added into reformulated sentence of the last comment.
3-533	A	18	11	18	22	References? (Kevin Trenberth, National Center for Atmospheric Research)	Added: Shiklomanov and Rodda (2003), EEA
3-534	A	18	11			"last decades"? (Kevin Trenberth, National Center for Atmospheric Research)	replaced by “in the 20th century” in the first sentence, and by “during the last three decades in the second sentence.
3-535	A	18	17			"insufficient" or excess? (Kevin Trenberth, National Center for Atmospheric Research)	Comment misplaced
3-536	A	18	19			Insert at the end of the period on line 19: "However, globally, on a per capita basis, agricultural water use, agricultural water consumption and irrigated area have	Studied the paper, suggested addition not considered necessary and can be derived from

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						declined somewhat since 1960 {Ref: Goklany, IM. 2002. Comparing 20th Century Trends in U.S. and Global Agricultural Land and Water Use. Water International 27 (3): 321-329.}" (Indur Goklany, Office of Policy Analysis, Department of the Interior)	indicated growth of irrigation areas
3-537	A	18	24	18	32	Here, it should be mentioned that these figures would be higher if ecosystem water requirements are considered in the analysis. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	The indicators to which the figures relate are clearly defined and there is no space to discuss the neglectence of ecosystem requirements.
3-538	A	18	24	18	24	Add after "... Greenhouse gases.": Furthermore precipitation formation is strongly ruled by aerosol cloud interactions which adds a further degree of complexity to this problem. (Sabine Wurzler, North-Rhine Westphalia State Environment Agency)	Comment misplaced.
3-539	A	18	26			Explanation of the scientific background of the threshold for per-capita water availability of 1000 m³/yr.c, which seems quite high on the first glauce. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	No space to do this here.
3-540	A	18	26			Explanation of the scientific background of the threshold for per-capita water availability of 1.000 m€/yr.c, which seems quite high on the first glauce. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Same as comment 3-540
3-541	A	18	31			"strong population dynamics" = "high rate of population growth"? (Robert Wilby, Environment Agency of England and Wales)	Replaced by “high population growth”.
3-542	A	18	33			Concerning "water stress and global water problems" is referred to Dyck, S.: Erfassung und Wertung der weltweiten Wasserproblematik" (Assessment and valuation of the global water problems). Hydrologie u. Wasserbewirtschaftung 43 (1999), H. 5, p. 233 - 241. The indicators of water crisis assessment are critically reviewed and the deficits in information and requirements for water-resources management are derived. Thus, the temporal and spatial resolution of water balances have to be improved, so that the variability of water availability can be measured in a better way. Dyck concludes that studies on the water balance of river basins have a tradition over more than 100 years in Germany. Pioneering work was done here also on a global scale. The scientific level reached today testifies that fundamental knowledge can be contributed to word-wide solutions of the problems. The results achieved so far can be further qualified by inclusion of the state-of-the-art of hydrology in modelling large rvier basins. In the field of water-resources management, too, Germany possesses especially in its large water associations high-level skills. (Lit. Morgenschweis, G. & zur Strassen, G.: Chpt. 11.16 "Germany - Use of Reservoirs for Low-Flow augmentation to Maintain the Drinking Water Supply" In: Tallaksen, L. M. & van Lauen, H. A. J.: Hydrological Drought. Processes and Estimation Methods for Streamflow and Groundwater.	Dyck paper is considered to have no new information relative to sensitivities to climate change. Other references maybe useful for 3.6.

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						Developments in Water Science 48, 2003 (Elsevier); Morgenschweis, G.; Heitefuss, C.: Use of a reservoir system for flood control in the Ruhr River basin in Germany: Positive effects and limittions. Proc. 73rd Annual Meeting of ICOLD May 1 - 6.2005 in Tehran/Iran, Symposium "Uncertainty in Dam Engineering", Theme S 2, pp. 1 - 7 (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	
3-543	A	18	33			chpt. 3.2.6: Concerning "water stress and global water problems is referred to Dyck, S.: Erfassung und Wertung der weltweiten Wasserproblematik" (Assessment and valuation fo the global water problems). Hydrologie und Wasserbewirtschaftung, 43 (1999), H. 5, p. 233 - 241. The indicators water crisis assessment are critically reviewd and the deficits in information and requirements for water-resources management are derived. So, the temporal and spatial resolution of water balance have to be improved, so that the variability of water availability can be measured in a better way. Dyck concludes that studies on the water balance of river basins have a tradtion over more than 100 years in Germany. Pioneerring work was done here also on a global scale. The scientific level reached today (WBGU 1998) testifies that fundamental knowledge can be contributed to world-wide solutions of the problems. the results achieved so far can be further qualified inclusion of the state-of-the-art of hydrology in modelling large river basins. In the field of water-resources management, too, Germany possesses especially in its large water associations high-level skills, which should be more intensively introduced into international activities (Morgenschweis et al. 2003, 2005). (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Comment is the same as comment 3-542.
3-544	A	18	35	21	15	As already mentioned, no information is given on insidious underground water contamination (Ar, F) (Osvaldo Canziani, IPCC)	Will be taken into account mentioning inorganic pollutants Addressed in section 3.4.7
3-545	A	18	37	21	15	3.2.7 is too long. Are these statements based on the long term of observed data? (Chunzhen Liu, Water Information Center,MWR)	The extent of observation period is given in text when available
3-546	A	18	37			"climate change"? (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-547	A	18	37	22	24	Both water quality and erosion effects of climate change are very indirect. Because the text has to be shortened drastically, I would suggest to leave out these parts (or make them much much shorter). The issues are important but it is clear that there are a) better fora where these issues are addressed, and b) primary impact of human behavior on water quality and erosion are orders of magnitude larger than the climate induced changes	Considered but not done, because in this chapter the water quality aspect is to be analyzed. Indirect effect of climate change are also important.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Nick van de Giesen, Delft University of Technology)	
3-548	A	18	48			Why? What about amount of precipitation, runoff etc? (Kevin Trenberth, National Center for Atmospheric Research)	OK considered
3-549	A	19	8	19	10	Comment "In many papers increasing/decreasing trends in lake/river DOC concentrations have been reported. For example, Freeman et al. 2004. Export of dissolved organic carbon from peatlands under elevated carbon dioxide levels. Nature, vol. 430, pp. 195-198." (Pirkko Kortelainen, Finnish Environment Institute)	OK, considered
3-550	A	19	10	19	14	Comment "The reference Rantakari & Kortelainen 2005. Interannual variation and climatic regulation of the CO2 emission from large boreal lakes. Global Change Biology 11: 1368-1380 could be included here. This paper demonstrates that annual CO2 emission from the largest Finnish lakes follows closely precipitation pattern with the highest emission during the years when the precipitation was highest." (Pirkko Kortelainen, Finnish Environment Institute)	OK, considered
3-551	A	19	16	19	41	Numerous important and interesting findings are enumerated in this long paragraph. Assimilation by the readers would be greatly facilitated if these findings were organized together in tabular form. A summary statement indicating what are the main implications would add value to the text. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Text rewritten
3-552	A	19	16	19	41	This alinea is based on literature that describes the impact of climate variability on water quality. Wouldn't it be more correct to write 'climate variability' instead of 'climate change' (lines 16,19, 24, 26, 28, 35, 36, 40). (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	OK, considered
3-553	A	19	16	19	41	add "Based on statistical analysis using meteorological and water quality data obtaied from 27 rivers in Japan, it was suggested that global warming has a deteriorating effect on river water quality (Ozaki et al., 2003)" Ozaki, N., Fukushima, T., Harasawa, H., Kojiri, T., Kawashima, K., and Ono, M. (2003) Statistical analyses on the effects of air temperature fluctuations on river water qualities. Hydrological Processes, Vol. 17, 2837-2853. (Takehiko Fukushima, University of Tsukuba)	OK, considered
3-554	A	19	16	35	41	The expression 'Climate change' repeated many times in a large broad context that is meaningless. Not clear what the expression actually stands for. Strong statements of attribution of climate change that are not clear. Methods to identify attribution should be explained. Location of studies, and assumptions used should be reported. Careful not to present impact study by observations only. Not sure if that is the case with this paragraph (Christel Prudhomme, Centre for Ecology and Hydrology)	OK, considered Location and conditions to get the presented data were included

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-555	A	19	16	19	41	Again the author has a clear impression about future changes in climate and relate it to water quality case studies. However we are (yet) not able to specify climate change effects regional with regard to precipitation, floods etc.. Makes it sense to specify here the impacts of assumed alterations of such characteristics at the example of specific river basins ? I'am sure that results depend strongly from the (very uncertain) basic assumptions. The examples given depend also from sensitivities of the models used used to determine these impacts? The lines 16 to 41 should be deleted. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Detail has been provided for the different studies reported.
3-556	A	19	16	19	41	Also L46; p 20 L12, L25-26: "climate change" used repeatedly and is vague: what changes in what variable over what period? Is it really change or variability? Many references missing. (Kevin Trenberth, National Center for Atmospheric Research)	OK, considered
3-557	A	19	26			See also: [1] Moss, B., McKee, D., Atkinson, D., Collings, S.E., Eaton, J.W., Gill, A.B., Harvey, I., Hatton, K., Heyes, T. and Wilson, D. 2003. How important is climate? Effects of warming, nutrient addition and fish on phytoplankton in shallow lake microcosms. Journal of Applied Ecology, 40, 782-792; [2] Webb, B.W., Clack, P.D. and Walling, D.E. 2003. Water-air temperature relationships in a Devon river system and the role of flow. Hydrological Processes, 17, 3069-3084; [3] Wade, A.J., Whitehead, P.G., Hornberger, G.M. and Snook, D.L. 2002. On modelling the flow controls on macrophyte and epiphyte dynamics in a lowland permeable catchment: the River Kennet, southern England. Science of the Total Environment, 282, 375-393. (Robert Wilby, Environment Agency of England and Wales)	Information from both papers was analyzed. Information from ref. Moss et al., was not considered because the study is a lab simulation to determine effects in fish caused by a 3oC temperature increase rather in water quality. A similar situation happened with the second reference
3-558	A	19	29			Please be specific - which are the "other confounding factors"? (Martin Savard, Geological Survey of Canada)	OK, considered
3-559	A	19	32	19	32	It is not only the effect of potassium cyanhidric and mercury wastes from gold and silver mining on fishes but mainly on pregnant woman whose foetuses are severely affected, resulting in generalized miscarriages, particular in riverine indigenous communities in Argentina, Bolivia and Paraguay. (Osvaldo Canziani, IPCC)	OK, considered
3-560	A	19	39			This statement seems to be not always correct, and some references should given to support the idea that "fractured or karstic aquifers have little specific yield". In my opinion this is not always true, as many karstic or fractured aquifers have high specific yield due to the presence of "dual porosity", so that after the fast karstic flow there are large volume of water stored in the matrix or in the finer fracture net.	This refers to page 39, line 16, and not to page 19 line 39 Comment has been addressed to the appropriate LAS

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						See for instance: Cambi C., Dragoni W. (2000): Groundwater, recharge variability and climatic changes: some consideration out of the modelling of an appenninic spring. Hydrogeology, vol. 4, ed. BRGM, pp. 39 - 53. (Walter Dragoni, Università di Perugia)	
3-561	A	19	43	19	49	Impact study, should be referred in 3.4 (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	OK, considered
3-562	A	19	43	19	49	It should be explained that most vegetation draws, through its membrane system, only fresh water, leaving salts brought by the rain and flodds in the sub surface. These salts are flushed into the groundwater once recharge takes place. (Arie S. ISSAR, Ben Gurion University of the Negev)	OK, considered but in section 3.4
3-563	A	19				The point is made that observations have shown increases in dissolved organic matter in lakes in Northern Europe. Note that this has also been observed for lakes in the USA (Stoddard et al., 2003). And there are papers that have reported increases in dissolved organic matter in rivers that have been related to various aspects of climate including temperature (Freeman et al., 2001, Worral and Burt, 2004), drought (Worral et al. 2004, Worral and Burt, 2004), and increasing discharge (Curtis 1988) Curtis 1988 p. 93-95 in Aquatic Humic Substances: Ecology and Biogeochemistry Hessen, D O and Tranvik, L J eds) Stoddard, J.L., J.S. Kahl, F.A. Deviney, D.R. DeWalle, C.T. Driscoll, A.T. Herlihy, J.H. Kellogg, P.S. Murdoch, J.R. Webb, and K.E. Webster. 2003. Response of Surface Water Chemistry to the Clean Air Act Amendments of 1990: EPA/620/R-03/001, U.S. Environmental Protection Agency, Corvallis, Oregon. 92 pp. Freeman, C., C.D. Evans, D.T. Monteith, B. Reynolds, and N. Fenner. 2001. Export of organic carbon from peat soils. Nature 412:785. Worrall, F., and T. Burt. 2004. Time series analysis of long-term river dissolved organic carbon records. Hydrol. Proc. 18: 893-912. Worrall, F., T. Burt, and J. Adamson. 2004. Can climate change explain increases in DOC flux from upland peat catchments? Sci. Total Environ. 326:95–112. (Thomas Huntington, U.S. Geological Survey)	OK, all references but Curtis (not available and from 1988) were taken into account
3-564	A	20	11	20	33	Regarding diarrhoea and other water-borne diseases, while climate is no doubt an important determinant of the geographical and temporal presence of pathogens, socio-economic factors may be more important in terms of the burden of disease. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	OK, but they are exacerbated by CCh consequences, this will be clarified in text

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-565	A	20	11	20	23	I think you should note another climate connection with drinking water quality. Climate change driven increases in DOC (Freeman et al., 2001; Freeman et al., 2004, Worral and Burt, 2004; Worral et al., 2004) will likely result in greater production of the bybproducts of the chlorination disinfection process – notably trihalomethanes (Siddiqui et al., 1997). Freeman, C., C.D. Evans, D.T. Monteith, B. Reynolds, and N. Fenner. 2001. Export of organic carbon from peat soils. Nature 412:785. Siddiqui, M.S., G.L. Amy, and B.D. Murphy. 1997. Ozone enhanced removal of natural organic matter from dring water sources. Water Res. 31:3098-3106. Worrall, F., and T. Burt. 2004. Time series analysis of long-term river dissolved organic carbon records. Hydrol. Proc. 18: 893-912. Worrall, F., T. Burt, and J. Adamson. 2004. Can climate change explain increases in DOC flux from upland peat catchments? Sci. Total Environ. 326:95–112. (Thomas Huntington, U.S. Geological Survey)	OK, considered all reference but Siddiqui one
3-566	A	20	11			Note that environmental and human health standards are potentially climate sensitive. See: Crane, M., Whitehouse, P., Comber, S., Ellis, J. and Wilby, R.L. 2005. Climate change influences on environmental and human health chemical standards. Human and Ecological Risk Assessment, 11, 289-318. (Robert Wilby, Environment Agency of England and Wales)	OK, considered
3-567	A	20	26	20	27	In 2000, ….WHO (2001): This needs further explaination. (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	OK, considered
3-568	A	20	26			It is very surprising that the impact of climate change on diarrhoe cases of a single year can be quantified. Obviously knows WHO more about climate change effects than the IPCC. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Reference was review and checked, WHO (Mitchel) describe how they arrived to this figure
3-569	A	20	26			Were the cases of diarrhoea really attributable to "climate change", or climate variables such as rainfall and temperature anomalies? (Robert Wilby, Environment Agency of England and Wales)	OK, it is due to extreme rainfall
3-570	A	20	33			Are these examples of failures in water treatment technology relevant for climate change impact assessments? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Yes, in developing countries
3-571	A	20	34			Perhaps there is a need for a paragraph on "Water quality and environmental health"? (Robert Wilby, Environment Agency of England and Wales)	OK

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3-572	A	20	38	20	39	While it is true that climate change is contributing to reduced water availability on the coasts, over-exploitation of limited water resources is a much more severe and short-term problem. This sentence should be rewritten to reflect the relative importance of the two problems. (Lenny Bernstein, IPIECA)	OK, considered
3-573	A	20	44	20	44	Add before “wetlands” the qualificative “coastal” to differentiate these from “inland wetlands” (Osvaldo Canziani, IPCC)	OK, considered
3-574	A	20	44			Specify "described in another chapter" (Robert Wilby, Environment Agency of England and Wales)	OK, considered
3-575	A	21	3			form > from (Levent Kavvas, University of California, Davis)	OK, considered
3-576	A	21	14			Vague (Kevin Trenberth, National Center for Atmospheric Research)	OK, intermittently is defined in text
3-577	A	21	18			In my opinion it should underlined that, at least in intensively farmed land, the most important agent impacting on soil erosion is agricultural practise. See for instance: Zhang XC, Liu WZ (2005): Simulating potential response of hydrology, soil erosion, and crop productivity to climate change in Changwu tableland region on the Loess Plateau of China AGRICULTURAL AND FOREST METEOROLOGY 131 (3-4): 127-142 AUG 31 2005 Bormann H, Fass T, Giertz S, Junge B, Diekkruger B, Reichert B, Skowronek A (2005): From local hydrological process analysis to regional hydrological model application in Benin: Concept, results and perspectives. PHYSICS AND CHEMISTRY OF THE EARTH 30 (6-7): 347-356 2005 Hamandawana H, Nkambwe M, Chanda R, Eckardt F (2005): Population driven changes in land use in Zimbabwe's Gutu district of Masvingo province: Some lessons from recent history APPLIED GEOGRAPHY 25 (3): 248-270 JUL 2005 (Walter Dragoni, Università di Perugia)	See reply to 3-159
3-578	A	21	18			If there is an increase in erosion, this may well be reflected in greater sediment loads (unless the sediment is intercepted before it enters straems and rivers. In a preliminary analysis of recent trends (~25 years for most) in the sediment loads of the 145 major rivers worldwide, Walling and Fang (2003) indicated "that ca. 50% of the sediment load records showed evidence of statistically significant upward or downward trends, with the majority evidencing declining loads. In the case of the	See reply to 3-159

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						annual runoff series, far fewer rivers (i.e. ca. 30%) showed evidence of statistically significant trends. The evidence afforded by the sample of the world's rivers indicates that reservoir construction is probably the most important influence on land–ocean sediment fluxes, but the influence of other controls resulting in increasing sediment loads could also be detected." In addition, Syvistski (2003) notes that "It has become increasingly difficult to assess the impact of changes in the sediment flux to the coastal zone because of the conflicting impacts of humans. Globally, soil erosion is accelerating (e.g., deforestation, some agriculture practices), while at the same time sediment flux to the coastal zone is globally decelerating (e.g., water diversion schemes, dams)." [Refs: [1] Walling, D.E. and Fang, D. 2003. Recent trends in the suspended sediment loads of the world's rivers. Global and Planetary Change 39: 111-126. [2] Syvitski, JPM. 2003. Supply and flux of sediment along hydrological pathways: research for the 21st century. Global and Planetary Change 39: 1-11.] (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-579	A	21	18			Why focus specifically on erosion? Changes in water balance terms affect a whole host of geomorphic processes including slope stability, channel change, sediment transport etc. See for example: Viles, H.A. and Goudie, A.S. 2003. Interannual, decadal and multidecadal scale climatic variability and geomorphology. Earth Science Reviews, 61, 105-131. There are also indirect consequences of geomorphic change for water quality. See for example: Longfield, S.A. and Macklin, M.G. 1999. The influence of recent environmental change on flooding and sediment fluxes in the Yorkshire Ouse basin. Hydrological Processes. 13, 1051-1066. (Robert Wilby, Environment Agency of England and Wales)	Changed
3-580	A	21	20	21	23	Superfluous (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	See reply to 3-159
3-581	A	21	20	22	24	3.2.8 is focused on the simulated results by model rather than on related current sensitivity/vulnerability, may suggest to move into page 49 3.4.8 (Chunzhen Liu, Water Information Center,MWR)	See reply to 3-159
3-582	A	21	20	21	22	Strong statement not supported by scientific evidence. DELETE, or add peer-reviewed journal paper reference based on analysis of long-records (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-583	A	21	20	21	23	This is not correct: see Trenberth et al 2003 for instance. (Kevin Trenberth, National Center for Atmospheric Research)	See reply to 3-159
3-584	A	21	25	25	41	Impact study, should be referred in 3.4 (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Changed
3-585	A	21	25	22	20	These paragraphs are written in a very different style than the forgoing sections of	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						the report. They seem to be more like a textbook and could be written more concisely with reference to citations for the background theory. Also there should be more citation of actual research papers that demonstrate these conceptual ideas. One aspect of the relation between soil susceptibility to erosion and climate that is not mentioned is the likely feedback between the loss of soil organic carbon that may accompany warming and the resultant loss of soil structure that will increase the susceptibility of the soil to erosion (Huntington, 2003) Huntington, T. G., Available Water Capacity and Soil Organic Matter. 2003, pages 1-5, Book Chapter In Lal, R. (ed.) Encyclopedia of Soil Science, DOI: 10.1081/E-ESS 120018496, Marcel Dekker, New York (Thomas Huntington, U.S. Geological Survey)	
3-586	A	21	25	21	41	As erosion depends very much from land-use practices and vegetation coverage the mono-causal relationship to precipitation and the discussion of the model sensitivity defined by Pruski and Nearing seems to be not sufficient. The part 3.2.8 should start with a characterization of the complexity and differentiate between driving forces (precip, land use etc,) and discuss expected changes afterwards. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	See reply to 3-159
3-587	A	21	28			How good is model, is it validated? (Kevin Trenberth, National Center for Atmospheric Research)	See reply to 3-159
3-588	A	21	30	21	31	This phrase is not fully correct. In fact erosion and the silting-up and clogging processes affecting the bed of watercourses, lakes, lagoons, and reservouirs happens both under heavy and light precipitation events. This is a particularl feature of flatland areas, such as the Pampas. L. F. Tricart FAO Consultant and Director of the Centre de Géographie Appliquée – Université de Strasbuurg, has analized the geomorphologic and edaphologic linkages in the etensive Argentina ´s Pampas (ref. Geomorfologia de la Pampa Deprimida, INTA (National Institute of Agropecuarian Technology), Buenos Aires, 1973). (Osvaldo Canziani, IPCC)	Changed
3-589	A	21	30	21	40	References (Kevin Trenberth, National Center for Atmospheric Research)	
3-590	A	21	43			How good are models? Need Earth System Models, not erosion models. (Kevin Trenberth, National Center for Atmospheric Research)	
3-591	A	21	43	21	50	etc: relates more to vulnerability than climate change. (Kevin Trenberth, National Center for Atmospheric Research)	
3-592	A	22	0			The title of this sub-section suggests an ambiguity that could be avoided.	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						'Adaptation by water management' suggests that the text will provide details of response mechanisms (and this is indeed the theme of the paragraph from Line 4 on P23), whereas the introduction to Section 3 clearly states that this element of the report is about the impact of climate change on water systems. . Perhaps simply 'Water Management' would be better ? (Paul Jeffrey, Cranfield University)	
3-593	A	22	1			'Given types of precipitation changes that have occurred over the last century'. DELETE. Not supported by scientific evidence (Christel Prudhomme, Centre for Ecology and Hydrology)	See reply to 3-159
3-594	A	22	3			Following the above, it would be opportune to also mentioned that erosion by-products - silting-up and clogging- also have an important role in the genesis of floods in flatland. Therefore lines 3 and 4 should read, after “climate change” in line 3, as follows “to influence global soil erosion, silting-up and clogging rates, with a net impact on flooding conditions, unless off-setting conservation measures are taken”. This drafting will warn decision makers on the need to focus attention on the geomorphological and pedological features of the environment when aiming at adaptation actions and flood warning systems in similar regions. (Osvaldo Canziani, IPCC)	See reply to 3-159
3-595	A	22	22			Also L30: what “climate change”? (Kevin Trenberth, National Center for Atmospheric Research)	
3-596	A	22	22	22	24	Probably the researcher has never observed snowmelt induced erosion… (Nick van de Giesen, Delft University of Technology)	See reply to 3-159
3-597	A	22	25			A fourth important impact of climate change is associated with the changes from forest cover du to the fires.We have to introduce a particular aspect related to the erosion induced by forest fires upstream of the watershed and which are caused by the increase of the heat waves occurrence. We can introduce a paragraph starting from line 25 as follows: " The arid and a semi arid regions, particularly in the développing countries, are concerned by the intensification of erosion due to deforestation and the no recovery of the forest cover after fires for human reasons (cost of forest recovery or low concern,..) or natural reasons (decrease in precipitations and increase in temperature and water evaopration)". (Mahi Tabet-Aoul, Association pour la Recherche pour le climat et l'environnement (ARCE))	See reply to 3-159
3-598	A	22	27			The points on page 22 are excellent (we've always adapted and we're all involved). However, the section itself is weak when it comes to discussing adaptation options. Given that adaptation will be discussed in Section 3.6, is section 3.2.9 necessary? (Rob de Loë, University of Guelph)	New section 3.6 (Adaptation)

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-599	A	22	27			chpt. 3.2.9: The cited results are correct, but does not meet hte nowadays realities in water management as e. g. - structural adaption like - surfall water dams - drainage canals - distribution network - pehaviour adaption like - water saving - water recycling etc. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	
3-600	A	22	27			chpt. 3.2.9: The cited results are correct, but do not meet the nowadays realities in water management as e. g. - structural adaption: - surface water dams - drainage canals - distribution network - behaviour adaption: - water saving, - water recycling - water pricing etc. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Section 3.2.9 is not anymore in SOD
3-601	A	22	27			SECTION COMMENTS: 3.2.9 is poor, it fails to deal with options, costs and environmental effects, changes expected in storms as 100 years return periods become 50 or 30 year storms, etc. (Christel Prudhomme, Centre for Ecology and Hydrology)	Same as before
3-602	A	22	27	23	14	WHY IS THERE NOTHING HERE ON ADDED UNCERTAINTY IN DECISION MAKING CONCERNING WATER RESOURCES MANAGEMENT? This is one of the clearest and most important implications of climate change and should be stressed here. (Nick van de Giesen, Delft University of Technology)	Same
3-603	A	22	29	23	14	This paragraph does not really add something (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	
3-604	A	22	31			I disagree with the statement that 'A distinctive property of the water sector is in the role of adaptation'. There is no single lesson from history in this regard but adaptation has often occurred through communities modifying their demands of a water supply system through changing economic or agricultural practices. The text gives the impression that the water sector itself is the dominant source of adaptation. (Paul Jeffrey, Cranfield University)	Point taken
3-605	A	22	32	22	33	It is true that human communities have always adapted to the changing conditions regarding water availability and demand. However this "adaptation" was undertaken within stable climate systems, in which water availability conditions returned to the previous situation once the climate variability passed. The situation will be quite different under a climate change trend; therefore to awake decision making's interest on adapting to the coming climate change and forget (to some extent) the type of adaptation which " has been the backbone of water management before now" appropiate warning is necessary at the earliest possible time. (Osvaldo Canziani, IPCC)	Poin taken

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-606	A	22	36	22	38	The statement that in principle every individual who uses water is a sort of water manager is true, but I suspect that there is a great difference in the awareness of this fact between developed and developing countries. The woman who draws water from a well in a developing country is far more likely to be aware of both water availability and water quality issues that the person in a developed country who merely turns on a water tap. Some discussion of this difference would be useful because it is at the root of many unsustainable water use practices. (Lenny Bernstein, IPIECA)	Point understood
3-607	A	22	40		44	Not sure who Appleton, et al are because the reference is incomplete in the reference list…. but "management" involves many more things than just regulation, control, allocation and distribution of existing supplies of water to offstream uses! This perspective is rather narrow. (Rob de Loë, University of Guelph)	OK
3-608	A	22	40			Management is not necessarily accountable; in addition, a lot of water management is done outside mandated responsibilities. (Richard S.J. Tol, Uni. Hamburg)	Thanks
3-609	A	22	46	22	49	What references? Vague: where, when? (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-610	A	22	46	22	49	Not related to adaptation. Merely restating some confusing info on observed decrease in riverflows without references. (Nick van de Giesen, Delft University of Technology)	OK
3-611	A	22	47	22	47	"page xx": specify number (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	OK
3-612	A	22	47	22	2	the statement regarding the prairie river system stream flow decline does not appear to have any qualifications regarding the natural or regulated flow which has been shown to have been a major source of reduction in stream flow on many prairie rivers nor the effect of decadal variability which could be significant given the relatively short historic record on the prairies. There is not a reference at this stage justifying this paragraph. (Harvey Hill, Prairie Farm Rehabilitation Administration)	OK
3-613	A	22	47			Boxe in page xx seems crucial - I would have liked to see it. (Martin Savard, Geological Survey of Canada)	OK
3-614	A	22	47			Trivial statement and even not fully correct "clean water supply is important for energy production"? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Section revised
3-615	A	22	48	23	1	In many regions…already begun: This information should not be given in this	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						paragraph (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	
3-616	A	22	48	23	49	This statement contradicts material found elsewhere in the chapter, see, eg., p. 8 on flows into the Arctic. See, also, the above comment for p. 14, lines 40-41. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Revised
3-617	A	22	48	23	1	Where are the prairies (the USA?). Too regional/specific. Very strong statement that needs to be supported by significant long-term trends in records. What is the influence of increase of water abstraction and use in the low-flows? Must also be mentionned. Could not find any paper mentionning significant decreases, while McKershar & Henderson 2003 and Adamosvki & Bocci (2001) show increasing trends, and many others no significant trend. In China, Xiong & Guo, 2004 link decrease in low flows with increase in water use. (Christel Prudhomme, Centre for Ecology and Hydrology)	Revised
3-618	A	22	48			If the author has the confidence that decreases in flow volume are already happening he should make a contribution to 3.2.1.. Maybe he should consider Page 7 Lines 42 - 44. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	??
3-619	A	22	49	22	49	missing rereference (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	OK
3-620	A	22	49			The authors might wish to consider the following two references Cunderlik, JM; Burn, DH, (2004) Linkages between Regional Trends in Monthly Maximum Flows and Selected Climatic Variables. Journal of Hydrologic Engineering [J. Hydrol. Eng.]. Vol. 9, no. 4, pp. 246-256. Jul-Aug 2004 Alcamo, J; Doell, P; Henrichs, T; Kaspar, F; Lehner, B; Roesch, T; Siebert, S, (2004). Development and testing of the WaterGAP 2 global model of water use and availability. Hydrological Sciences Journal/Journal des Sciences Hydrologiques [Hydrol. Sci. J./J. Sci. Hydrol.]. Vol. 48, no. 3, pp. 317-337. Jun 2003. (Paul Jeffrey, Cranfield University)	Thanks
3-621	A	22	49	23	2	The author should discuss his findings with the authors of 3.2.1 and 3.2.3 to come to a common statement. Obviously the views are very different! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	New section in SOD
3-622	A	22		23		Illustrative of the omission is subsection 3.2.9 (pages 22 and 23), which addresses "adaptation by water management" but which contains no mention at all of irrigation subsidies. All around the world, these subsidies are huge, with cost	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						recovery on irrigation projects (which the authors point out account for a large share of total water use and consumption) rarely exceeding 20 or 25 percent. How is water management supposed to improve without a reform of pricing policies? By not describing the magnitude and impacts of irrigation subsidies, the authors of this chapter are missing an opportunity to bolster the case for reform – which would result in prices that fully reflect the expense of delivering water to farmers as well as the opportunity cost of using water for irrigation (as opposed to channeling it to household and other uses). (Douglas Southgate, Ohio State University)	
3-623	A	23	1			It would be opportune to add after problems: "and, hence, management water strategies" so to read " This water supply problems and, hence, management water strategies, should be carefully considered" (Osvaldo Canziani, IPCC)	Yes
3-624	A	23	1			This is incorrect. (Kevin Trenberth, National Center for Atmospheric Research)	
3-625	A	23	4	23	14	The planting of trees to reduce albedo and increase rainfall, should be mentioned as an adaptation policy in semi arid regions (Ben Gai et al. 1993, 1998) (Arie S. ISSAR, Ben Gurion University of the Negev)	
3-626	A	23	4	23	14	It is also worth pointing out that there is little empirical research on appropriate matches between water supply / management regimes and periods of high climate variability. Much of what we see in the literature is conjecture (often well meaning and well argued) and / or reasoning by analogy - i.e.using historical evidence on how climate / water management systems have been coupled and system level properties (such as flexibility) as the basis for intervention. (Paul Jeffrey, Cranfield University)	
3-627	A	23	6			Within the brackets replace "variations", instead of changes so to read : "coping with climate variations" (Osvaldo Canziani, IPCC)	Section revised
3-628	A	23	6			I take issue with the suggestion that structural adaptation such as dams increase the flexibility of management options. If anything, they decrease flexibility because they "lock in" certain types of uses and economic activities. This point is well addressed in the water literature. (Rob de Loë, University of Guelph)	Point taken
3-629	A	23	6			What means " coping with climate change"? Delete! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Disagree
3-630	A	23	8			Rewrite line 8 as follows: "…although SOME OF THE BENEFITS OF these	

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						options MAY BE REDUCED SINCE THEY CAN generate social …" (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-631	A	23	8			What about reservoirs? (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-632	A	23	9			There should be a discussion of non-structural options, including development of property rights for water, transferrable water rights, water pricing. Other options include developing and using crops with low water demand, changing agronomic practices (e.g., greater use of precision agriculture), even desalinization (a "structural" option). {see Goklany (2000,2002, 2005b), and references therein]. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	OK
3-633	A	23	10	23	14	Infrastructure adaptation should include considerations related to comment # 4 (Martin Savard, Geological Survey of Canada)	OK
3-634	A	23	11			Design decisions can often be based on relatively short hydrometric records that underplay the full extent of natural variability. Long-term river flow reconstruction can help provide information on earlier extremes/ natural variability and hence reliable yields even under present climate conditions. See for example: Jones, P.D., Lister, D.H., Wilby, R.L. and Kostopoulou, E. 2005. Extended river flow reconstructions for England and Wales, 1856-2002. International Journal of Climatology, in press. (Robert Wilby, Environment Agency of England and Wales)	
3-635	A	23	14	23	15	Comments could be added here regarding the potential role of changes in the operation of water resources infrastructure as a means of adapting to changes. Although there has not been, to the best of my knowledge, a great deal of research in this area, I believe there is considerable potential and this seems to be a logical place to indicate this. (Donald Burn, University of Waterloo)	
3-636	A	23	15			This section should be expanded to provide more detiled information to the readers. Adaptation management options should be presented in more detils. I would suggest addition of (a) realocation of storage in the reservoirs; (b) modification of operational rules for water related infrastructure; (c) introduction of monitoring to assist the water conservation; and (d) real time optimization of water use (in irrigation; hydropwoer production; water supply; etc.) (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	
3-637	A	23	27	25	26	3.3.1 "climate" should be focused on the future climate, concerning the impact of climate change and variability on water resources ,such as page 23 line 38---page 24 line 40,and page 25 line 19-26, it would be better to move into page 27 3.4.1	*Page 25 line 19-26 will remain in section 3.3.1 as they show what assumptions on future climate are made when compute freshwater*

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						(Chunzhen Liu, Water Information Center,MWR)	*impacts of climate change. (Petra)*
3-638	A	23	27			chpt. 3.3.1: This chapter reveals a principal discrepancy: Due to the uncertainties of the climate models and the large variability of its results in my personal opion only the multi-model probabilistic approach (cp. Line 27) is suitable to assess the impact of climate change on water resources, but never theless a great number of results cited in this chaptes are derived from only one climate model! The latter results it used at all should be valuated much more cantious. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Partially interesting. Point taken
3-639	A	23	27			chpt. 3.3.1: This chapter reveals a principal discrepancy: Due to the uncertainties of the climate models and the large variability of its results in my opion only the multi-model probabilistic apprach (cp. line 27) is suitable to assess the impact of climate change on water resources; but nevertheless a great number of results cited in this chapter are derived from only a single climate model. These results should be interpreted much more cautious. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Same as before
3-640	A	23	27			Section 3.3.1. Whole section needs sharpening, be better organised, and needs tidying-up references. Problem of scale, extremely important in GCM modelling, completly over-looked (Christel Prudhomme, Centre for Ecology and Hydrology)	Section revised
3-641	A	23	29	23	36	The statement in this section that there will be decreases in precipitation in the sub-tropics and there will be mid-latitude drying does not appear to be consistent with the conclusions of Chapter 10 in the WGI draft report. An important caveat from the WGI report is not mentioned, which reads (page 19 in Chap 10, WGI draft report) "decreases in precipitation over sub-tropical areas are less consistent than the increases at high latitudes." (Chuck Hakkarinen, retired (2002) from Electric Power Research Institute)	Same as before
3-642	A	23	29			General comment to part 3.3.1.: The most scientists agree that regional specified prognoses of climate change are very uncertain. These uncertainties can be specified by inter-comparison of different GCM-results for the region of interest. It is not understandable why this approach which was suggested by Arnell some years ago is not applied in general. The simplification: one GLM - one downscaling - one hydrological model one value impact seems should not be used further. Resulting from this statement page 23 line 38 to page 24 line 3 should be deleted as the contradiction with page 24 line 23 - 30 are obvious. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	*Should be deleted (Petra)*
3-643	A	23	29	23	44	Section 3.3.1: L29-44 this is a model result. Depends on model and scenario and	*Should be deleted (Petra)*

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						time. (Kevin Trenberth, National Center for Atmospheric Research)	
3-644	A	23	30	23	32	The full sentence contained in this text is vague. There is little meaning in saying that precipitation change can occur with a probability of 80%, etc., unless the amount of change is specified. Also, it would be helpful to explain what DJF and JJA mean. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-645	A	23	30	23	33	One of the conclusions…..DJF and JJA: Strange statement, needs further explaination or should be removed. (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	
3-646	A	23	30	23	31	'One of the conclusion (…) with an 80% probability by the end of the century' Needs more explanation. Which GCM used to reach this statement? Is it a global or regional statement, and precipitation totals or intensities. Not useful statement at present (Christel Prudhomme, Centre for Ecology and Hydrology)	Deleted
3-647	A	23	31	23	32	Furer & Tebaldi not in ref list (Martin Savard, Geological Survey of Canada)	OK
3-648	A	23	31	21	32	Furrer and Tebaldi: Not in references, please cross-check all references. (Nick van de Giesen, Delft University of Technology)	
3-649	A	23	31			Furrer and Tebaldi (2005) missing from refs (Robert Wilby, Environment Agency of England and Wales)	
3-650	A	23	32	23	36	The projections made here reflect what will happen in the future; I am not sure how this addresses the underlying "assumptions", which is the concern here (see section heading). (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-651	A	23	38	23	38	The opening sentence of this paragraph is far too general. Can be omitted. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	*I suggest to delete lines 38-44 (Petra)*
3-652	A	23	39	23	44	Again, nothing is said about "assumptions", such as scenaria, GCM versions and types, hydrological models used, etc. As is, this paragraph belongs more in Section 3.2.1 than here. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	*I suggest to delete lines 38-44 (Petra)*
3-653	A	23	40			Using the intemediate step of "downscaling". Maybe this should be explained here? (Hayley Fowler, Newcastle University)	Section revised
3-654	A	23	40			For even-handedness it should be noted that statistical downscaling methods are also used extensively to link GCM output and water resource models. There are plenty of examples in the literature. (Robert Wilby, Environment Agency of England and Wales)	Same as before

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3-655	A	23	40			For another example of direct coupling of RCMs and hydrological models, see: Hay, L.E., Clark, M.P., Wilby, R.L., Gutowski Jr., W.J., Arritt, R.W., Takle, E.S. and Pan, Z. 2002. Use of Regional Climate Model output for hydrologic simulations. Hydrometeorology, 3 571-590. (Robert Wilby, Environment Agency of England and Wales)	
3-656	A	23	41	23	44	It is not clear the period within which these modeled projections show an increase in annual precipitation. Is it 2-14% for the coming 20, 30 years ? Furthermore; is there any reference on the increased annual precipitation due to the remarkable ocean warming (order of magnitude 1023 Joules for all the world oceans)? It would be important to have such reference. (Osvaldo Canziani, IPCC)	Section revised
3-657	A	23	41	23	41	Sushama reference appears to be related to an article that has been submitted but not yet reviewed. Is that a valid reference? (Harvey Hill, Prairie Farm Rehabilitation Administration)	Yes, until TSU deadline date
3-658	A	23	43			It should be stated over what period the increase was observed. (Thomas Huntington, U.S. Geological Survey)	OK
3-659	A	23	43	23	44	Comment "By contrast the paper Raymond & Cole 2003. Increase in the export of alkalinity from North America's largest river. Science, vol 301, pp. 88-91 shows that discharge in the Mississippi River has increased during the years 1950-2000." (Pirkko Kortelainen, Finnish Environment Institute)	OK
3-660	A	23	44			Also see work by my group where we have used RCM output to look at water resource vulnerability in northwest England and how management practices may have to be changed in future. See: Fowler, H.J. and Kilsby, C.G. Using regional climate model data to simulate historical and future river flows in the UK. Climatic Change, accepted subject to minor revision, and Fowler, H.J., Kilsby, C.G. and Stunell, J. Modelling the impacts of projected future climate change on water resources in northwest England. Hydrology and Earth System Science, in press. (Hayley Fowler, Newcastle University)	
3-661	A	23	46	24	3	Similar comment as above (discusses vulnerability rather than assumptions) (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-662	A	23	46	23	3	As written (especially the last sentence) the text suggests a universal conclusion when in fact Fowler et al 2003 are referring specifically to Yorkshire. Yorkshire is mentioned in the paragraph, but it isn't crystal clear that this is a Yorkshire-specific conclusion! (Rob de Loë, University of Guelph)	
3-663	A	23	47			It should be stated where Yorkshire is. (Thomas Huntington, U.S. Geological Survey)	

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3-664	A	23	47			Yorkshire: say it's in the UK - Much too local (very small region of the UK). Would recommand not to cite the example (Christel Prudhomme, Centre for Ecology and Hydrology)	
3-665	A	23	49			"Result indicate further improvements in water resource reliability…but reductions in resource resilience and increased vulnerability.."requires more explanation for apparent contradiction. (Robert Wilby, Environment Agency of England and Wales)	
3-666	A	24	5			In my opinion the statement that "anthropogenic emissions of greenhouse gases lead" are the (main or the only) causes of the present warming has not been proven. I think that some doubts should be left, expecially thinking to the climatic changes of the last millennia. Cf. for instance: Martinez-Cortizas, A., Pontevedra-Pombal, X., Garcia-Rodeja, E., Novoa-Muñoz, J.C. and Shotyk, W. 1999. Mercury in a Spanish peat bog: Archive of climate change and atmospheric metal deposition. Science 284: 939-942. Dragoni W. (1998): Some considerations on climatic changes, water resources and water needs in the Italian region south of the 43°N. In "Water, Environment and Society in Times of Climatic Change". Issar A., Brown N. editors. Kluwer, pp. 241 - 271. Issar A. S. (2003): Climate Chages during the Holocene ans their Impact on Hydrological Systems. International Hydrology Series, Cambridge University Press, pp.127. (ISBN 0527817269). (Walter Dragoni, Università di Perugia)	
3-667	A	24	5			This paragraph could be shortened considerably without loss of information. (Hayley Fowler, Newcastle University)	*But comment 3-671 likes the paragraph as is (Petra)*
3-668	A	24	5	25	2	The uncertainities when computerized models are applied should be reduced by simulation with historical climate changes. The proxy data for deciphering the historical climate changes and impacts is abundant ranging from historical documents to paleo-hydrological data (river, lake and sea levels), changes pollen and faunal assemblages, changes in speleotheme growth and their isotopic contents etc. etc. (Issar and Brown (eds.), 1998, Issar 2003, Issar and Zohar 2003). In general it should be stated that the investigations of recent past climates (prior to the time of instrumental measurements) should be encouraged as they ay help in simulation of climate and hydrological models for regions and periods for which data is scarce. In other cases data may serve to to forecast impacts on the natural as well as socio-economic systems, according to the principle of "The past is the key for the future"	

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						(Arie S. ISSAR, Ben Gurion University of the Negev)	
3-669	A	24	5	24	21	Needs to be shortened and sharpened. Needs reference. Must mention GCM uncertainty. Results should be given with range of projected potential changes (and number of GCMs looked at) (Christel Prudhomme, Centre for Ecology and Hydrology)	*GCM uncertainty is specifically addressed in this paragraph and the nex.t Ranges are difficult as they are strongly scale dependent (Petra)*
3-670	A	24	5	24	7	This is a function of aerosols and changes are likely to be small in amount. (Kevin Trenberth, National Center for Atmospheric Research)	
3-671	A	24	5	24	21	This is a very lucid paragraph. I hope the whole chapter will read like this in the final draft. Give this reasoning a more prominent place. (Nick van de Giesen, Delft University of Technology)	*Where to put it?(Petra)*
3-672	A	24	7	24	8	Need reference to sentence 'climate models agree that evaporation demand will increase in the future'. Is that true? For the whole globle, and all the seasons? Needs developing (Christel Prudhomme, Centre for Ecology and Hydrology)	*CHECK WGI; but I think for the whole globe due to increased T, future cloudiness is rather uncertain (Petra)*
3-673	A	24	8			This line is wrong because " runoff and water resources will decrease unless there is a sufficient increase in precipitation". The negative "not" is wrong. (Osvaldo Canziani, IPCC)	Corrected.
3-674	A	24	8			In other words, the actual evporation will be constrained by regional precipitation and soil moisture changes. (Robert Wilby, Environment Agency of England and Wales)	yes
3-675	A	24	10	24	12	Please, provide due reference for the statement: "In addition, while temperatures will increase ….". This statement is too general and does not seem to clearly give scientific information on expected precipitation changes. (Constanta-Emilia Boroneant, National Meteorological Administration)	*???*
3-676	A	24	12	24	13	The full sentence contained in this text is superseded by the next one; can be deleted. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Removed; next sentence reformulated.
3-677	A	24	16			The information between brackets shall be completed simply because physically-wise, the atmosphere heat content is not due to direct warming from the Sun or GHG effect but because of the latent condensation heat of increased evaporation from the remarkable world oceans' warming because of the increasing greenhouse warming. The remarkable oceans'warming also modifies oceans' circulations, with a net effect on the moisture content of sea-land advection fluxes. (Osvaldo Canziani, IPCC)	*I still think the sentence is correct, as it says nothing about a direct warming.*
3-678	A	24	16	24	17	This is not right (Kevin Trenberth, National Center for Atmospheric Research)	*Need to talk to meteorologists (Petra)*
3-679	A	24	18	24	19	The full sentence contained in this text should be amplified. In what regions do	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						model-predicted precipitation changes have different signs ? Are there any regions where all models predict the same sign of precipitation change ? Are we talking here about annual precipitation ? How about seasonal distributions ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-680	A	24	19	24	19	Please, include "However, " before the sentence: Parameter uncertainty of a climate model …" (Constanta-Emilia Boroneant, National Meteorological Administration)	
3-681	A	24	21	24	21	Murphy et al reference did not appear in the bibliography (Harvey Hill, Prairie Farm Rehabilitation Administration)	*Added (Petra)*
3-682	A	24	21			Murphy et al. 2001 reference is missing. (Levent Kavvas, University of California, Davis)	*Added (Petra)*
3-683	A	24	23	25	2	Good, informative paragraphs, stressing the comparison between model-generated and scenario-generated uncertainty. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-684	A	24	23	24	30	"The uncertainties of the impact of climate change on water resources…" is also due to the lack of a fully-coupled quantification of atmosphere-land interactions in regional hydroclimate models. This is especially the case in tropical monsoon regions (Xue et al. J. Geophys. Res. 109, D03105, 2004). (Levent Kavvas, University of California, Davis)	
3-685	A	24	23	24	26	But distribution of aerosols is critical. (Kevin Trenberth, National Center for Atmospheric Research)	YES
3-686	A	24	25			"…assumed climate sensitivities.." to what? (Robert Wilby, Environment Agency of England and Wales)	
3-687	A	24	26			What about uncertainties introduced by the choice of downscaling method? This should also be mentioned here. i.e see work by Andy Wood et al. 2004 in special issue of climatic change (january) (Hayley Fowler, Newcastle University)	
3-688	A	24	30			For a recent analysis of multiple sources of uncertainty (emissions, GCM, downscaling, hydrologic model etc) affecting low flow projections see: Wilby, R.L.and Harris, I. 2005. A framework for assessing uncertainties in climate change impacts: low flow scenarios for the River Thames, UK. Water Resources Research, in press. (Robert Wilby, Environment Agency of England and Wales)	*We could discuss here (and not scattered in 3.4) the uncertainties of RGC and statistical downscaling for water resources (Petra)*
3-689	A	24	32	24	37	The sentence is too long, too many details that loose in clarity. Please, reformulate synthetysing the results. (Constanta-Emilia Boroneant, National Meteorological Administration)	
3-690	A	24	32	25	17	This part can probably be shortened; a link to the WGI findings may be sufficient.	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Dieter Gerten, Potsdam Institute for Climate Impact Research)	
3-691	A	24	32	25	2	Repetition of paragraph l5 to 21. Both should be merged together. Very surprising NOT to see reference of intercomparison project (e.g. Covey et al., 2003). Should be included (Christel Prudhomme, Centre for Ecology and Hydrology)	OK
3-692	A	24	32	24	38	This is function of scenario and might better be done as % per K. (Kevin Trenberth, National Center for Atmospheric Research)	
3-693	A	24	32	24	49	Should deal with precipitation amount, intensity, frequency, type etc., and should deal with aerosol effects in short-circuiting hydrological cycle. (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-694	A	24	37	24	38	The statement: "Both the global annual temperature and precipitation changes increase during the 21st century" is unclear in respect to precipitation. Precipitation will change differently according to region and season. Please, be more specific and add due reference. (Constanta-Emilia Boroneant, National Meteorological Administration)	
3-695	A	24	42	24	42	I would suggest to use insead of "predicted temperature changes" - "projected temperature changes" (Constanta-Emilia Boroneant, National Meteorological Administration)	disagrre
3-696	A	24	45	24	45	I would suggest to use insead of "Predicted precipitation changes" - "projected precipitation changes" (Constanta-Emilia Boroneant, National Meteorological Administration)	Same as before
3-697	A	25	2			This implies that precipitation driven changes may be hard to discern from natural variability at regional scales until the second half of the 21st Century. (Robert Wilby, Environment Agency of England and Wales)	Section revised
3-698	A	25	4	25	17	These two paragraphs discuss projected changes, rather than "assumptions". They belong more in Section 3.4 than here. The text from line 4 to line 11 is repeated on page 40 (11 to 19). (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	*They belong here, because section 3.4 deals with impacts on freshwater, not precipitation. Delete lines 11-19 on page 40. (Petra)*
3-699	A	25	4	25	11	Problem of GCM and scale MUST be mentionned when talking of heavy precipitation events. At the coarse GCM resolution, not possible to model correctly phenomenon at the origin of heavier rain, due to lack of topographical information, and because the processes at the origin are at finer scale than GCM. See e.g. Jones et al., 1995 on scale-dependant modelling of precipitation. Should mention necessity of downscaling methods (dynamical or statistical), GCM not reliable at short temporal scale. Statement 'It is very likely that heavy precipitation events will increase' is doubtful. By which models? Which downscaling technique? Where? What type of events etc.... Too vague at the moment.	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Christel Prudhomme, Centre for Ecology and Hydrology)	
3-700	A	25	4	25	11	Only Europe? (Kevin Trenberth, National Center for Atmospheric Research)	
3-701	A	25	4	25	11	There seems to be a mix here of measured, conjectured, and projected changes. (Nick van de Giesen, Delft University of Technology)	Ok
3-702	A	25	11			A greater contribution from heavy rain days is also projected for North America, see: Wilby, R.L. and Wigley, T.M.L. 2002. Future changes in the distribution of daily precipitation totals across North America. Geophysical Research Letters, 10.1029/2001GL013048. (Robert Wilby, Environment Agency of England and Wales)	
3-703	A	25	13	25	17	References? (Kevin Trenberth, National Center for Atmospheric Research)	
3-704	A	25	15			You should also mention that climate models generally agree that the NAO becomes increasingly more positive under global warming (see work by Nathan Gillett): Gillett NP et al. 2002. Climate change and the North Atlantic Oscillation. In: Hurrell JW et al. (eds.) The North Atlantic Oscillation – Climatic significance and environmental impact, AGU Monograph Series, AGU. (and I am sure that there are probably more recent references). (Hayley Fowler, Newcastle University)	
3-705	A	25	16			Provide a supporting reference for changes in ENSO. (Robert Wilby, Environment Agency of England and Wales)	
3-706	A	25	19	25	26	The authors have drawn attention to the important issue of how GCMs perform when applied to observed data, and how they compare amongst themselves in this regard. This a major concern when attempting to quantify changes in the hydrologic regime of a river basin. Any amplification on this subject would valuable, if some relevant literature is available. For my part, I can suggest the following: Bonsal, B.R., T.D. Prowse and A. Pietroniro. 2003. An Assessment of Global Climate Model-Simulated Climate for the Western Cordillera of Canada (1961-90).” Hydrological Processes, 17: 3703-3717. Töyrä, J., Pietroniro, A. and Bonsal, B. 2005. Evaluation of GCM Simulated Climate over the Canadian Prairie Provinces. Canadian Water Resources Journal Vol. 30(3): 245–262. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-707	A	25	19	25	26	References? Inadequate. (Kevin Trenberth, National Center for Atmospheric Research)	
3-708	A	25	21	25	22	Remove the part of the sentence "which ...". (Dieter Gerten, Potsdam Institute for Climate Impact Research)	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-709	A	25	23	25	26	The phrases in these lines should be recalled when, at the chapter's end, the requirements are placed. Data, both meteorological and hydrological, are very badly needed, particularly in developing regions. (Osvaldo Canziani, IPCC)	
3-710	A	25	25	25	26	Is this still current practice? (for examples see also section 3.4.1) (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	
3-711	A	25	26	25	26	(e.g. Danihlik et al., 2004) DANIHLÍK, R. - HLAVCOVÁ, K. - KOHNOVÁ, S. - PARAJKA, J. - SZOLGAY, J.: Scenarios of the change in the mean annual and monthly runoff in the Hron Basin. J. Hydrol. Hydromech., 52, 2004, 4, 291-302 (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	
3-712	A	25	26			I am not sure that this is still true - people are now looking at changes to variability etc by either using SD methods as an intermediate step, i.e. Fowler et al 2003 used a weather generator and changed mean and variability, also using outputs of RCMs directly with bias-correction as we have done in Fowler, H.J. and Kilsby, C.G. Using regional climate model data to simulate historical and future river flows in the UK. Climatic Change, accepted subject to minor revision, and Fowler, H.J., Kilsby, C.G. and Stunell, J. Modelling the impacts of projected future climate change on water resources in northwest England. Hydrology and Earth System Science, in press, is also a way of examining changes in both mean, variability and extremes. It may be true to say that "Until recently, most climate change impacts studies for freshwater have only considered changes in precipitation and temperature, based on changes in the averages of long-term monthly values as provided by climate models..." But then I think that a discussion is needed as to how the field has recently moved on to look at the impacts of mean and variability changes - not many people have gone on to look at third-moment changes (i.e. skewness or change in the extreme) but this has been done by a few - notably the study above, using bias-corrected RCM climatic (precipitation and temperature) data directly as input to catchment models and thus accounting for changes to the extremes (full distribution of temperature and precipitation). I know that Nigel Arnell has done some work on mean and variability changes in comparison to mean only changes. I am sure that there are also many others. (Hayley Fowler, Newcastle University)	*We should follow this advice and discuss these references (Petra)*
3-713	A	25	26			For an example where changes in daily variability has been taken into account (and compared with conventional scenarios that do not), see: Diaz-Nieto, J. and Wilby, R.L. 2005. A comparison of statistical downscaling and climate change factor methods: impacts on low flows in the River Thames, United Kingdom. Climatic	*Include these examples (Petra)*

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						Change, 69, 245-268. (Robert Wilby, Environment Agency of England and Wales)	
3-714	A	25	32			The phrase shall be improved for decision makers' sake, reading after the bracket, as follows: Is basically influenced by increased demands from the explosive population growth, as reflected by land use, water impoundments, groundwater overexploitation and poor waste water-treatment as well as because mean sea level-rise, ... (Osvaldo Canziani, IPCC)	Not appropriate to talk of explosive population growth as it is already declining globally.
3-715	A	25	36			Off-hand mention of the "paradigm" of Integrated Water Resources Management is not convincing. The authors should at least foreshadow that IWRM will be addressed in Section 3.6.1. BUT, as noted below, I'm concerned about the extent to which it is handled effectively in that section -- so I'd suggest careful consideration of the point's importance here. (Rob de Loë, University of Guelph)	IWRM will be introduced in Section 3.1
3-716	A	25	36			Explain IWRM, or refer to section 3.6. Also, is it possible to discuss *observed* relative contributions of climate and non-climatic factors? (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Refer to section 3.6. Relative contributions are already discussed in section 3.2.6.
3-717	A	25	46			replace "surface water dams" with "dams" (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Replaced.
3-718	A	25	49			An additional reference is the Earthscan publication on The Future of Large Dams, by T. Scuddler, 2004 (Osvaldo Canziani, IPCC)	Reference added.
3-719	A	25	50	25	50	Takeuchi reference not in bibliography (Harvey Hill, Prairie Farm Rehabilitation Administration)	Citation deleted as not of central importance..
3-720	A	25	50			Misleading. Only 3 dams have been removed in France out of 100! (Christel Prudhomme, Centre for Ecology and Hydrology)	Replaced by a "weaker" formulation.
3-721	A	26	4			But desalination has major energy implications. (Robert Wilby, Environment Agency of England and Wales)	Is mentioned now.
3-722	A	26	16			For a review of literature on climate change impacts, water quality and ecological status, see: Wilby, R.L., Orr, H.G., Hedger, M., Forrow, D. and Blackmore, M. 2005. Risks posed by climate change to delivery of Water Framework Directive objectives. Environmental International, in press. (Robert Wilby, Environment Agency of England and Wales)	Relevant for section 3.4.7 of FOD
3-723	A	26	20	26	26	This supports the implications mentioned relative to nitrate lodaing and health issues (see comment #4).	o.k.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Martin Savard, Geological Survey of Canada)	
3-724	A	26	27			This line and some additional one must include a well founded explanation of natural insidious contamination by heavy metals, already affecting approximately 100 million people, a number which will increase with overexploitation of aquifers in many part of the world (Osvaldo Canziani, IPCC)	Covered in section 3.4.7 of FOD
3-725	A	26	33			The soybean boom expands the wrong use of land and this crop´s brutal expansion impacts on water use in water stressed areas in many countries in South America (Argentina, Bolivia, Brazil, Paraguay, etc) (Osvaldo Canziani, IPCC)	Yes, but not very relevant here.
3-726	A	26				3.3.2 Pricing policy is mentioned, though just barely, nearly the bottom of page 26, in subsection 3.3.2 – on "non-climatic drivers" of future trends. One can make the case that irrigation subsidies will be scrutinized more closely as water availability diminishes and non-agricultural demands for water grow. A logical outcome of this scrutiny would be improved cost-recovery in irrigation systems and better on-farm water management. Such an outcome is not examined in this subsection or, as far as I can tell, anywhere else in the chapter. The same subsection contains Bruinsma's (2003) estimate that irrigated area in developing countries will increase by 20 percent between now and 2030 (page 26). I am unfamiliar with this study, although I would appreciate an explanation of how the projection of 20 percent growth can be reconciled with the finding of the World Commission on Dams that new dams are not being constructed at a very rapid place. Furthermore, I wonder if the 2003 study takes into account pricing issues and inter-sectoral conflicts over increasingly scarce water issues. Another study, which addresses these issues, projects that irrigation development will proceed at a much slower pace during the next few decades. [See Mark Rosegrant, Ximing Cai, and Sarah Cline, "Global Water Outlook to 2025," International Food Policy Research Institute, Washington, 2002.] (Douglas Southgate, Ohio State University)	Such pricing impacts are explicitly included in the assumed irrigation water use efficiencies mentioned in the section. Regarding the large values of Bruinsma, in the section the much lower growth estimates of the MEA are given, too (which reflect more the thinking of Rosegrant et al.), such that the high uncertainty of this type of assumptions about future trend becomes clear.
3-727	A	27	7			What about water allocation for ecosystems? This is the rationale behind much water lincensing in the UK. (Robert Wilby, Environment Agency of England and Wales)	Assumptions on increasing allocation for ecosystems added in third paragraph of section 3.3.2
3-728	A	27	9			Section 3.4 covers a lot of ground that is covered well in numerous other recent reports and studies. More importantly, the "global" scale summaries offered here, which occasionally dip down to local or regional scales, are – in my opinion – of questionable value. As the authors recognize themselves in the chapter, water is one	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						context where the local and regional impacts of climate change are critical; this point sometimes is lost in these very general global summaries of patterns and trends. As will become clear in subsequent comments, I think there's far too much material in Section 3.4 at the expense of important material in subsequent sections. One solution is to pare down the discussion in Section 3.4 considerably to make room. (Rob de Loë, University of Guelph)	
3-729	A	27	9			As shown in examples noted above, there's lots of duplication in section 3.4. I'm sure I read the statement about CO2 concentrations and leaf stomatal resistance 3 times already by page 51. Many opportunities exist to trim and rationalize in the chapter. (Rob de Loë, University of Guelph)	
3-730	A	27	9	47	26	Section 3.4: For some of the global Figures references need to be added (Fig 3.3, 3.4, 3.6, 3.7, 3.8). Other global Figures refer to not yet published (Lehner, 2005) or not easy accessible publications (Doll, 2005) (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Lehner et al. (2005) will be published soon, Döll (2005) is in a peer-reviewed journal, and in AR4 even grey literature is to be included. (Petra)
3-731	A	27	9			Section 3.4 sub-headings should be made distinct from section 3.2 sub-headings. For example, something like "3.4.1 Projected atmospheric and ..." or "3.4..1 Future atmospheric and …" (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	*We do need to discuss this (Petra)*
3-732	A	27	9			Section 3.4. How are statements [Medium confidence] [High confidence] etc.. made? Seems arbitrary from text. Needs more scientific justification to whole section (Christel Prudhomme, Centre for Ecology and Hydrology)	
3-733	A	27	11	27	11	Why is this the core of the chapter? This is all based on climate models that are very weak with respect to water. 3.3, 3.7&3.8 are stronger and more important. (Nick van de Giesen, Delft University of Technology)	*There is some truth in it (Petra)*
3-734	A	27	20			Section 3.4.1: The material in this section would be easier for the reader to assimilate if it were organized under a few sub-headings, such as modelling methodology; modelling uncertainties; projected runoff changes; projected changes in river flows; and conclusions from catchments studies. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Good idea (see 3-731)
3-735	A	27	20			Section 3.4.1. Much of this section appears to be centered around the study of Nohara et al. (2005) and the WEM results (though it is not always clear to what study the text refers). So, this section can be significantly shortened, and potentially be complemented by findings from other studies. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Agree

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3-736	A	27	20	51	1	there is lack of confidence level, except 3.4.4 Groundwater (Chunzhen Liu, Water Information Center,MWR)	
3-737	A	27	20			Section 3.4.1. General: long and a bit misleading as uncertainty is only marginally mentionned. One has the impression of certainty in projections from the text, which does not reflect the reality of modelling by GCMs. Needs sharpening, and a better intellectual integrity in reporting results from the impact community! Reference list is far from exhaustive with some key impact studies missing. In particular, work by Wilby on downscaling and uncertainty is completely missed out while it is of very high quality. Section generally messy, with part of uncertainty much too small compared to the rest (only 10 lines compared to 8.5 pages). Must be re-worked - Major revisions, including problem of scale and uncertainty having major part in the section (Christel Prudhomme, Centre for Ecology and Hydrology)	Restructuring as noted above will help: we'll be more explicit too about methodological issues
3-738	A	27	31			Please define what you mean by "arbitrary climate changes" (Hayley Fowler, Newcastle University)	Non-GCM-based scenarios, such as +/-10%. We'll clarify in text
3-739	A	27	34			The assumption of a 1% per yr increase in CO2 concentrations seems somewhat unrealistic considering the Mauna Loa CO2 record shows an average increase of about 0.4% per year increase from 1959 to 2004, with a max year-to-year increase of about 0.75% {see Keeling and Whorf 2005, at CDIAC]. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	This is the standard IS92a scenario
3-740	A	27	35	27	36	There are at least two additional studies in table 3.2 that have used SRES scenarios: Andréasson et al., 2004; Graham, 2004. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Thanks for the references
3-741	A	27	36			Please add Fowler and Kilsby (in press): Fowler, H.J. and Kilsby, C.G. Using regional climate model data to simulate historical and future river flows in the UK. Climatic Change, accepted subject to minor revisions.We used SRES Scenarios (based on UKCIP02) to look at changes in river flows in NW England. (Hayley Fowler, Newcastle University)	Thanks for the references
3-742	A	27	36			Reference of use of SRES emission scenarios: Prudhomme et al., 2003; Bergant & Kajfez, 2005; Zhao et al., 2005; Andreasson et al., 2004, Kay et al., 2005a,2005b etc…. (Christel Prudhomme, Centre for Ecology and Hydrology)	Thanks for the references
3-743	A	27	36			See also Wilby and Harris (2005) above (Robert Wilby, Environment Agency of England and Wales)	
3-744	A	27	39			Table 3.2 Consider to re-arrange the table into line continous type of listing. In that case random empty boxes would have some delimiting function. (Gábor BÁLINT, VITUKI Environmental Protection and Water Management	OK

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						Research Institute)	
3-745	A	27	39			Table 3.2 Add new item to Europe: Szolgay, J. - Hlavcová, K. - Lapin, M. - Danihlík, R.: Impact of climate change on mean monthly of runoff in Slovakia. Meteorological Journal, 6, 2003, 3, 9-21 Region: Slovakia, Carpathian Range (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Thanks for the reference
3-746	A	27	39			Table 3.2 "needs to be updated", per author's comment. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See above
3-747	A	27	39	29	1	In its present form, Table 3.2 conveys very little useful information to the reader. Either delete the table or expand it with a brief summary of each of the references listed. (Lenny Bernstein, IPIECA)	We'll discuss in light of comments, and consider altering/changing it. It may be that there are now too many references for the table to be helpful
3-748	A	27	39			"Table 3.2", "Please, include the following reference for Europe, Danube river, Romania : Rimbu et al. (2002) (Constanta-Emilia Boroneant, National Meteorological Administration)	Thanks for the reference
3-749	A	27	39			"Table 3.2", "Please, consider appropriate arrangement of published studies by continents, country/regions, river basins, as in this form it is unclear (Constanta-Emilia Boroneant, National Meteorological Administration)	Thanks
3-750	A	27	39			I did not find Table 3.2 particularly insightful, beyond making the point that there have been many studies looking at changes in river flows as a result of climate change. Given the space limitations, perhaps the table could be replaced with a short paragraph highlighting a select number of studies that are particularly good examples of this type of analysis. (Donald Burn, University of Waterloo)	We'll discuss in light of comments, and consider altering/changing it. It may be that there are now too many references for the table to be helpful
3-751	A	27	39			chpt. 3.4.1: Table 3.2 is unclear and incomplete. Can maybe cancelled without loosing much information. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	We'll discuss in light of comments, and consider altering/changing it. It may be that there are now too many references for the table to be helpful
3-752	A	27	39			May be table 3.2 is not usefull in this report. (Batima Punsalmaa, Institute of meteorology and Hydrology)	We'll discuss in light of comments, and consider altering/changing it. It may be that there are now too many references for the table to be helpful
3-753	A	27	39	29	3	I do not see the need fot Table 3.2. These references should all appear in the reference list at the end of the Section, and within the text. This type of Table does appear in other sub-sections, so I can only assume it is not be a feature of the report as a whole. (Nick Reynard, Centre for Ecology and Hydrology)	We'll discuss in light of comments, and consider altering/changing it. It may be that there are now too many references for the table to be helpful

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3-754	A	27	39	29	1	Not very clear what this huge table adds to the discussion. Work on West Africa is missing (and most likely also on other regions). (Nick van de Giesen, Delft University of Technology)	We'll discuss in light of comments, and consider altering/changing it. It may be that there are now too many references for the table to be helpful
3-755	A	27	39	27	40	Veijalainen, N. and Vehviläinen, B. 2004. Climate change and design floods in Finland. XXIII Nordic Hydrological Conference, Tallinn, Estonia,8-12 August 2004, NHP report no.48. ISBN 9985-56-921- 0 : Design precipitation (recurrence time 1000-10000 years) increases up to 40-60 % can cause problems for dams below small catchments (10-500 km2). Increase of monthly or seasonal precipi-tation together with winter snowmelt are reasons for design flood increase for dams below large catchments (over 10 000 km2). In catchments with large lake systems late summer, autumn or win-ter floods will be the design floods in the future. (Bertel Vehviläinen, Finnish Environment Institute)	Thanks for the references
3-756	A	27	40	29	1	Table 3.2 should be organized better. It is very hard to follow the information provided. I would suggest addition of some studies that I am aware of published in CANADA (1. Mortsch, L., Hengeveld, H., Lister, M., Lofgren, B., Quinn, F., Slivitzky, M., Wenger, L., 2000. Climate change impacts on the hydrology of the Great Lakes – St. Lawrence System. Canadian Water Resources Journal 25(2), 153-179; 2. Burn, D.H., Simonovic, S.P., 1996. Sensitivity of reservoir operation performance to climatic change. Water Resources Management 10, 463-478; 3. Burn, D.H., 1998. Climatic change impacts on hydrological extremes and the implications for reservoirs. Proc., Second Intl. Conf. on Climate and Water, Espoo, Finland, 273-281; 4. Burn, D.H., 1994. Hydrological effects of climatic change in west-central Canada. Journal of Hydrology 160, 53-70; 5. Westmacott, J.R., Burn, D.H., 1997. Climate change effects on the hydrological regime within the Churchill-Nelson river Basin. Journal of Hydrology 202, 263-279; 6. Coulibaly, P., and Y.B. Dibike, 2004. Downscaling of global climate model outputs for flood frequency analysis in the Saguenay River system, Department of Civil Engineering, McMaster University, Hamilton, Climate Change Action Fund, Project S02-15-01, 87pp.). Please add to the refernce quoted - Cunderlik and Simonovic (2004)- two much more accessible references: 1. Cunderlik, J., and S.P. Simonovic, (2005) "Hydrologic Extremes in South-western Ontario under future climate projections", Journal of Hydrologic Sciences, 50(4):631-654. 2. Cunderlik, J., and S.P. Simonovic, (2005) "Inverse Flood Risk Modeling Under Changing Climatic Conditions", Hydrological Processes Journal (in print). (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Thanks for the references

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-757	A	27	40	28		Table 3.2. The following paper could be cited on Aisa Column in Table 3.2: Yuan F., Z. Xie, Q. Liu, J. Xia, 2005: Simulating Hydrologic Changes with Climate Change Scenarios in the Haihe River Basin. Pedosphere, 15(5): 595-600. (Zhenghui Xie, Institute of Atmospheric Physics, Chinese Academy of Sciences)	Thanks for the references
3-758	A	27				Table 3.2 : It has poor information on LAm rivers. Cross - refer with Chapter 13 Latin America (Osvaldo Canziani, IPCC)	Will do
3-759	A	28	0			Addition to work on Europe: Chang, H., C. G. Knight, M. P. Staneva, D. Kostov. Water resource impacts of climate change in southwestern Bulgaria, GeoJournal 57:159-168 (2002) (C. Gregory Knight, Pennsylvania State University)	Thanks for the references
3-760	A	28	36	28	36	Rosenberg et al (2003) is not included in the reference list (Richard Betts, Met Office)	OK
3-761	A	28	36	28	39	In contrast, Cramer et al (2000), Global Change Biology, and Betts et al (submitted to Nature - I can supply to TSU) found that in a number of DGVMs and also in the Hadley Centre Earth System Model, increases in runoff due to vegetation responses to CO2 (including stomatal responses and changes in plant growth) were greater than those due to climate change. (Richard Betts, Met Office)	We'll refer to this explicitly in the revised CO2 discussion
3-762	A	28				Table 3.2: Please add Fowler and Kilsby (in press) to the table under Europe - we investigated impacts of climate change on river flows in northwest England - in reference: Fowler, H.J. and Kilsby, C.G. Using regional climate model data to simulate historical and future river flows in the UK. Climatic Change, accepted subject to minor revisions. Also, the hydrological impacts papers from PRUDENCE should be included - esp. those of Phil Graham et al (these are all in review or in press). (Hayley Fowler, Newcastle University)	Thanks for the references
3-763	A	29	0			Table 3.2 The citation for Huntington (2003) does not appear in the text. Huntington, T. G. Climate warming could reduce runoff significantly in New England, 2003. Agricultural and Forest Meteorology, 117:193-201 (Thomas Huntington, U.S. Geological Survey)	Thanks for the references
3-764	A	29	0	34		I really like the WEM angle/approach and the figures and findings thereafter. I found it to be the most informative and important contribution to this chapter. (Mark Svoboda, National Drought Mitigation Center)	Thank you
3-765	A	29	0	29		All. A key issue is how well models do the past record.	?

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						(Kevin Trenberth, National Center for Atmospheric Research)	
3-766	A	29	3	29	36	Ditto. (Arie S. ISSAR, Ben Gurion University of the Negev)	?
3-767	A	29	3	29	21	The whole paragraph needs re-writing. Problem of scale must be mentionned when talking about hydrology in GCMs: a river cannot be properly routed, and main physical drivers of rainfall-runoff modelling (orography, land type, vegetation, soil and geology) are not well described (meaningless at GCM scale). Must be very carefull on these results. Feedbacks are important, but modelling at much smaller scale makes much more sense in terms of hydrology - river systems do no follow large grid in nature! Statement l 20-21 is wrong. Off-line impact studies in hydrology are NOT done because it is easiest, but because it makes much more physical sense to model hydrological processes at catchment-scale rather than GCM scale (authors ackowledge themselves that modelling of runoff by GCMs is not good!). Why results of Covey et al. are not referenced??? (Christel Prudhomme, Centre for Ecology and Hydrology)	Will take this into account in revised text
3-768	A	29	3			Meaning unclear "Besides scenarios adopted in these studies, also methodologies…" (Robert Wilby, Environment Agency of England and Wales)	Will clarify
3-769	A	29	6	29	8	What about RCMs? There are at least three studies in table 3.2 (perhaps more?) that use RCM-generated scenarios: Andréasson et al., 2004; Arnell et al., 2003; Graham, 2004. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Will emphasise use of RCMs
3-770	A	29	9	29	11	Mention that the GCMs' (and other models') representation of runoff is compromised by the dearth of, and biases in, current observational databases on precipitation (and discharge). (Dieter Gerten, Potsdam Institute for Climate Impact Research)	OK
3-771	A	29	13			"The" situation is further complicated if "the" climate change signal (Hayley Fowler, Newcastle University)	OK
3-772	A	29	19		21	Please explain this sentence better - it does not make sense presently. (Hayley Fowler, Newcastle University)	Will clarify
3-773	A	29	23	29	36	WEM may be the best we can do at the moment but this should not be presented too much as the solution to poor GCM predictions. Clearly, variance of the mean is still extremely large, with differences between models being much larger than differences between scenarios. (Nick van de Giesen, Delft University of Technology)	Good point
3-774	A	29	28			Min et al. (2004) missing from refs (Robert Wilby, Environment Agency of England and Wales)	OK

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3-775	A	29	29			Explain the WEM estimation in greater detail, esp. How the weights were determined ? quotation? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	OK
3-776	A	29	33	29	34	Not sure about results with GCM assessed on their reproductibility of river discharge (which we know they ALL do wrong: it is not because a GCM does it a bit less wrong than another that it must be trustable). How can this assessment can be made at a GCM scale (appart from very large rivers such as the Amazon, the majority cannot be checked!) (Christel Prudhomme, Centre for Ecology and Hydrology)	Will revise text
3-777	A	29	36			Wilby and Harris (2005) applied weights to GCM-downscaling pairs based on an impacts-relevant skill measure, to produce cumulative distribution functions of future low flows in the River Thames. (Robert Wilby, Environment Agency of England and Wales)	Will include
3-778	A	30	1			Define WEM (Martin Savard, Geological Survey of Canada)	OK
3-779	A	30	19			Figure 3.3. Indicate source. Provide better resolution. If possible separate and provide much better copy of the right hand side of the figure. Text should explain this part of the figure. I think that this is one of the very important findings of this report. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	OK
3-780	A	30	20			What is the source of Fig 3.3? (Robert Wilby, Environment Agency of England and Wales)	OK
3-781	A	30	27	30	27	What is the "individual land surface model"? Reference? (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	OK
3-782	A	30	27			Were the different land-surface schemes of each GCM used to generate the weighted ensemble mean runoff? (Robert Wilby, Environment Agency of England and Wales)	Will clarify
3-783	A	30	28			"annual mean and runoff" > "annual mean runoff" (Levent Kavvas, University of California, Davis)	Will revise
3-784	A	30	29	30	31	Not sure what is meant by this. (Nick van de Giesen, Delft University of Technology)	Will clarify
3-785	A	31	1	31	4	What can you say about the other continents? (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Will add text
3-786	A	31	5			Figure 3.4. Indicate source. Provide better resolution. Text should explain this part of the figure. I think that this is one of the very important findings of this report.	

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	
3-787	A	31	6			Figure 3.4. and whole section. There is a need to see map of errors in reproducing global runoff before agonizing over potential future changes (as presented e.g. p 33 l13 to 28). Reference to confidence intervals/ range of results must be included. Is a 5% increase significant? It is very likely that the error in runoff estimation is greater than 5%! Also, the variation is GCMs projections as also likely to be much greater than 5%. The whole paragraph presents average results - but such average results are not useful while range of results, with associated likelihood if possible should be mentioned. The uncertainty attached to GCM modelling is essential for a good interpretation of the results. Results seem to show a draw back from IPCC 2001, where likelihood was mentionned as THE thing that would need to be done in good climate change impact studies (Christel Prudhomme, Centre for Ecology and Hydrology)	Figure 3.5 shows effect of different GCMs. It is difficult to map errors because these are not known: we don't have reliable maps of "truth". Figure 3.5 also explicitly takes significance of change into account.
3-788	A	31	6			Figure 3.4: annual runoff not very useful as seasonal dependence is critical for wet and dry seasons. (Kevin Trenberth, National Center for Atmospheric Research)	OK – but needed to save space!
3-789	A	31	21			What is the reference for the statement,"The climate change signal is greater than the effect of natural decade-to-decade variability across much of the world by 2050 ...."? Earlier references, such as that of Wolock and McCabe,1999. J.AWWA, 35(6), showed otherwise. (Levent Kavvas, University of California, Davis)	Arnell (2003) as cited in text
3-790	A	31	25			What is the meaning of a timing of streamflows? (Timing related to what (seasons?) ?) (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Timing through the year
3-791	A	31	25			"Where hydrological regimes are more sensitive to changes in precipitation…" this sentence should be a headline message for policy-makers, because it counters the notion that just because changes in river flows can not yet be detected, does not mean that changes are not taking place. (Robert Wilby, Environment Agency of England and Wales)	Good point
3-792	A	31	30			How many ensemble members were used from each GCM to construct Fig 3.6? If just one realisation per GCM, then the plot could still be underplaying the true extent of the uncertainty. (Robert Wilby, Environment Agency of England and Wales)	Will clarify
3-793	A	32	1	34	9	Either include fig 3.7 or 3.5 but not both because that only adds confusion. (Nick van de Giesen, Delft University of Technology)	Agree – will reduce

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-794	A	32	4			Figure 3.5. As presented this figure is of no use. Resolution should be better. Figure should be bigger. Serious ddisucssion of differences among climate models should be presented. Otherwise figure is of no value. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Will seek to improve resolution. Will add reference to differences between models
3-795	A	32	5			Fig 3.5: models dated. (Kevin Trenberth, National Center for Atmospheric Research)	They're the only ones that have been used to run off-line global-scale hydrological models
3-796	A	32	10			Hosaka et al is not in the reference list. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	OK
3-797	A	33	0			No good reason to believe models except to provide possibilities to build resilience. (Kevin Trenberth, National Center for Atmospheric Research)	Agree
3-798	A	33	2	33	5	Confusing? Needs better explanation. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	OK
3-799	A	33	3			Clarify the sentence "For example, the runoff at the mouth…" (Robert Wilby, Environment Agency of England and Wales)	OK
3-800	A	33	4	33	5	Explain the difference you made between runoff at the mouth and discharge and explain the differences in the direction of changes! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	OK
3-801	A	33	7			Figure 3.6 Indicate source. Improve resolution. Introduce legend. Explain the wide range of variation from year 2000 on. Again, very important but of limited use as presented. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	OK
3-802	A	33	8			What is the source of Fig 3.6? (Robert Wilby, Environment Agency of England and Wales)	OK
3-803	A	33	13	34	4	The enumerated information could be presented more effectively in a table (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	OK
3-804	A	33	13	34	4	The information in this section would be more suitable for a table. (Sten Bergström, Swedish Meteorological and Hydrological Institute)	OK
3-805	A	33	13			Since the increasing deforestation of the Amazon pluvious forest may reduce the annual precipitation by 50%, and the Amazon river basin system flow depends on rainfall, it would be important to define the "future", that is, until when such + 5% slight increase in the Amazon River discharge might happen (Osvaldo Canziani, IPCC)	OK
3-806	A	33	13	33	28	Is this all still based on Hosaka?	Will clarify

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Nick van de Giesen, Delft University of Technology)	
3-807	A	33	15	33	19	The decreasing trends of the Euphrates and the increase in the Nile due to increase in runoff in the upstream, as well as a decrease of the precipitation from the Mediterranean to Caspian Sea was deduced by analysing historical proxy data (Issar 2003, Issar and Zohar 2004) (Arie S. ISSAR, Ben Gurion University of the Negev)	Thanks for the references
3-808	A	33	20	33	20	What does the Rhine have to do with rainfall decrease between the Mediterranean and the Caspian? (Nick van de Giesen, Delft University of Technology)	Will alter text
3-809	A	34	1	34	5	Discusion of these significant increases must be provided. Why? Is the similar observed in other northern countries? Comparison of these results with Peterson et al should be expanded. Which one to believe? Arnell 2005 is not in the reference list. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Will add.
3-810	A	34	6			Figure 3.7. Indicate source. Provide explanation (what is R2?) improve resolution. Text should carefully explain the findings presented. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	OK
3-811	A	34	7			Fig 3.7: model and scenario dependent. (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-812	A	34				Figure 3.7: What shows this figure? The discharge of the main basins? Or grided runoff values? How was river discharge mapped and related to areas instead to river basin outlets? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Will clarify
3-813	A	35	1	36	4	Value-adding discussion and generalized conclusions drawn from the preceding review of literature. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-814	A	35	1	35	2	The precise conclusions of the catchment -scale studies doesn't list in Table 3.1, in which there is current vulnerability only. (Chunzhen Liu, Water Information Center,MWR)	Will revise text
3-815	A	35	1			correct: Table 3.2 (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	
3-816	A	35	5	35	14	Comment "The following references could be included in the text: Vehviläinen, B. & Huttunen, M. 1997. Climate change and water resources in Finland. Boreal Environment Re-search 2:3-18. ISSN 1239-6095.	Thanks for the references

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						Bergström, S., Andreasson, J., Beldring, S., Carlsson, B., Graham, P., Jónsdóttir, J., Engeland , E., Turunen, M. and Vehviläinen, B. 2003. Climate change impacts on water resources in the Nordic countries, State of the art and discussion of principles. CHIN, Nordic Council of Ministers. ISBN 9979-68-120- 9." (Pirkko Kortelainen, Finnish Environment Institute)	
3-817	A	35	5	35	14	This is again a key finding (and not surprisingly it is amply supported by the literature). These first order temperature effects should be put forward prominently. (Nick van de Giesen, Delft University of Technology)	OK
3-818	A	35	5	35	14	Confirmation of temperaure effect on snow melt and runoff in Finland: Hyvvärinen; V. 2003. Trends and Charateristics of Hydrological Time Series in Finland. Nordic Hydrology, 34(1/2),2003, 71-90; Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095: Winter runoff increases considerably due to increase in snowmelt and rainfall and spring floods decrease in southern Finland. In northern Finland spring floods increase at first due to increase in snowfall but later with continuous warming spring flood decrease is valid in northern Finland. (Bertel Vehviläinen, Finnish Environment Institute)	Thanks for the references
3-819	A	35	6	35	7	Andréasson et al., 2004 does not concern the Alps, but on the other hand it does concern the Nordic region. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Thanks!
3-820	A	35	19	35	28	Is this all tropics and subtropics? Function of location. (Kevin Trenberth, National Center for Atmospheric Research)	Will clarify
3-821	A	35	21			Add in references: Fowler, H.J. and Kilsby, C.G. Using regional climate model data to simulate historical and future river flows in the UK. Climatic Change, accepted subject to minor revision and Fowler, H.J., Kilsby, C.G., and O'Connell, P.E. 2003. Modeling the impacts of climatic change and variability on the reliability, resilience and vulnerability of a water resource system. Water Resources Research, 39(8), 1222, doi:10.1029/2002WR001778. These both show increased seasonality of flows. (Hayley Fowler, Newcastle University)	Thanks
3-822	A	35	27			What is the meaning of "bring a season forward"? (Related to what?) (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Bring timing forward: will revise text
3-823	A	35	35	35	43	Hydraulic interventions (dams, canalization) have a much larger and clearer effect. (Nick van de Giesen, Delft University of Technology)	Will add
3-824	A	35	39	35	39	Missing reference: Barlage et al , 2002 No corresponding reference is listed in	OK

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						REFERENCES (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	
3-825	A	35	41			The expression "may be more similar" is not a scientific one! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	OK!
3-826	A	35	42	35	43	Is the runoff in Australian rivers reduced by climate change and deforestation? Or, is it afforestation? Please clarify (Osvaldo Canziani, IPCC)	Will clarify
3-827	A	35	48			See also: Fowler, H.J. and Kilsby, C.G. Using regional climate model data to simulate historical and future river flows in the UK. Climatic Change, accepted subject to minor revision and work of Phil Graham et al in PRUDENCE (and other PRUDENCE generated papers) (Hayley Fowler, Newcastle University)	Thanks for the reference
3-828	A	35	50			For an evaluation of the significance of hydrological model uncertainty to river flow scenarios, see: Wilby, R.L. 2005. Conditioning hydrological model parameters for climate change impact assessment. Hydrological Processes, 19, 3201-3219. (Robert Wilby, Environment Agency of England and Wales)	Thanks for the reference
3-829	A	36	0			Some duplication… points made about groundwater were made earlier in the chapter (Rob de Loë, University of Guelph)	OK
3-830	A	36	0			General comment on Subsection 3.4.2.: A fundamental factor in actual ET is the soil moisture availability for root water uptake which is function of moisture distribution dynamics within the soil. Since ET acts as a boundary condition to soil moisture dynamics, this is a fundamental nonlinear phenomenon which is yet to be modeled realistically by land surface hydrology models. Another fundamental uncertainty in computations of ET by current hydrology modelis is the presence of heterogeneity of soil hydraulic parameters and vegetation patterns within a model grid (eg. above Yoshitani et al. reference). (Levent Kavvas, University of California, Davis)	OK
3-831	A	36	3	36	4	"…hydrological model uncertainty is generally small compared to errors in the modelling procedures or difference in climate scenarios…" This statement depends on what is meant by hydrological modeling. If one considers regional hydroclimate modeling as hydrological modeling, then the uncertainty in the downscaling of hydroclimatic variables (ET, soil water storage, etc.) from the coarse grid resolution (~300km) of AOGCMs to regional scale grid resolution (~15km) can be very substantial due to the significant smoothing of the actual topography in	Will clarify: we mean here water budget modelling using input-output models

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						mountainous regions (see Yoshitani,J. et al. 2002. "Regional-scale hydroclimate model". Chp 7 in Watershed Models of Large Watershed Hydrology, Ed.by V.P.Singh and D.K.Frevert, Water Resour.Pub.LLC.). (Levent Kavvas, University of California, Davis)	
3-832	A	36	4			It may also be worth mentioning here the use of multiple climate model outputs in impact studies and their comparison - some recent work on this (the first that I have seen) uses bias-corrected output from the PRUDENCE RCM simulations to look at impacts on the hydrology of the Baltic Sea area (see Phil Graham et al for more details) (Hayley Fowler, Newcastle University)	Will add
3-833	A	36	4			Wilby and Harris (2005) also show that hydrological model (parameter and structural) uncertainty are second order compared with the choice of GCM and downscaling technique. (Robert Wilby, Environment Agency of England and Wales)	Thanks for the reference
3-834	A	36	5			So what is the conclusion related to different downscaling techniques? (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Will add
3-835	A	36	9	36	10	In this sentence, I would remove what's in parenthesis after meteorological and hydrological, or better define what each is. Hydrological drought is much more than just river discharge volumes; it is snowpack, reservoirs, and groundwater as well. Maybe water supply would capture the essence of their meaning? Meteorological drought summed up with just "less rainfall" isn't descriptive enough either in my opinion. (Mark Svoboda, National Drought Mitigation Center)	OK
3-836	A	36	10			Good to define the diverse aspects of droughts; but, this section is almost exclusively focused on hydrological drought. If possible, provide examples especially on agricultural drought (or provide links to other chapters where these are discussed). (Dieter Gerten, Potsdam Institute for Climate Impact Research)	We've deliberately concentrated on hydrological drought
3-837	A	36	16	36	26	Not informative. 1) What is the likelihood of quadrupling of C02? Should link this experiment to SRES scenarios (the 'reference scenarios from IPCC 2001) at the very least! 2) Which GCMs have been used? Results will depend on that. 3) How well the soil moisture is modelled by GCMs? Doubt it is good! Whole paragraph to be deleted as does not add anything (Christel Prudhomme, Centre for Ecology and Hydrology)	Good point – will probably remove example
3-838	A	36	16	36	17	The sentence beginning with "Particularly" needs clarified or rewritten. The use of the word "suppress" may not be the best choice given the current context of the	OK

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						sentence. I'm sure it could be reworded to include it though. Is the choice of evaporation in this sentence the intent over evapotranspiration? (Mark Svoboda, National Drought Mitigation Center)	
3-839	A	36	19	36	19	What GCM and version is being referred to ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See below
3-840	A	36	19			It was shown that different GCM´s (and different runs of a single GCM) provide very different results. Is the utilization of a single GCM simulation really a representative result which should be discussed here? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Good point
3-841	A	36	19	36	26	Not realistic, model dependent. (Kevin Trenberth, National Center for Atmospheric Research)	Good point
3-842	A	36	19	36	19	Is quadrupled CO2 a normal SRES scenario? (Nick van de Giesen, Delft University of Technology)	Good point
3-843	A	36	28	36	42	The authors state that most previous studies have assumed that increasing CO2 will have no direct effects on evaporation or that reduced stomatal conductance will be offset by increased crop growth. Such an assumption is not wise. It is true that the very first free-air CO2 experiments did show not significant effects of CO2 on evapotranspiration (e.g. Dugas, W.A., M.L. Heuer, D.J. Hunsaker, B.A. Kimball, K.F. Lewin, J. Nagy, and M. Johnson. 1994. Sap flow measurements of transpiration from cotton grown under ambient and enriched CO2 concentrations. Agricultural and Forest Meteorology 70:231-245; Hunsaker, D.J., G.R. Hendrey, B.A. Kimball, K.F. Lewin, J.R. Mauney, and J. Nagy. 1994. Cotton evapotranspiration under field conditions with CO2 enrichment and variable soil moisture regimes. Agricultural and Forest Meteorology 70:247-258; Kimball, B.A., R.L. LaMorte, R.S. Seay, P.J. Pinter Jr., R. Rokey, D.J. Hunsaker, W.A. Dugas, M.L. Heuer, J.R. Mauney, and G.R. Hendrey. 1994. Effects of free-air CO2 enrichment on energy balance and evapotranspiration of cotton. Agricultural and Forest Meteorology 70:259-278.) However, these first experiments were conducted on cotton, a woody C3 species with a large CO2 growth response (about 40% for a 200 ppm increase in CO2; Mauney, J.R., B.A. Kimball, P.J. Pinter Jr., R.L. LaMorte, K.F. Lewin, J. Nagy, and G.R. Hendrey. 1994. Growth and yield of cotton in response to a free-air carbon dioxide enrichment (FACE) environment. Agricultural and Forest Meteorology 70:49-67.). In contrast, more recent FACE experiments with sorghum, a C4 grass, had an insignificant CO2 growth response (Ottman, M.J., B.A. Kimball, P.J. Pinter Jr., G.W. Wall, R.L. Vanderlip, S.W. Leavitt, R.L. LaMorte, A.D. Matthias, and T.J. Brooks. 2001. Elevated CO2	Thanks for the references

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						increases sorghum biomass under drought conditions. New Phytologist 150(2):261-273.), while at the same time it had a significant reduction in evapotranspiration (about 13% for a 200 ppm increase in CO2; Conley, M.M., B.A. Kimball, T.J. Brooks, P.J. Pinter Jr., D.J. Hunsaker, G.W. Wall, N.R. Adam, R.L. LaMorte, A.D. Matthias, T.L. Thompson, S.W. Leavitt, M.J. Ottman, A.B. Cousins, and J.M. Triggs. 2001. CO2 enrichment increases water use efficiency in sorghum. New Phytologist 151(2): 407-412; 183. Triggs, J.M., B.A. Kimball, P.J. Pinter Jr., G.W. Wall, M.M. Conley, T.J. Brooks, R.L. LaMorte, N.R. Adam, M.J. Ottman, A.D. Matthias, S.W. Leavitt, and R.S. Cerveny. 2004. Free-air carbon dioxide enrichment effects on energy balance and evapotranspiration of sorghum. Agricultural and Forest Meteorology 124:63-79). Wheat was intermediate between cotton and sorghum (Hunsaker, D.J., B.A. Kimball, P.J. Pinter Jr., R.L. LaMorte, and G.W. Wall. 1996. Carbon dioxide enrichment and irrigation effects on wheat evapotranspiration and water use efficiency. Transactions of the ASAE 39(4):1345-1355; Hunsaker, D.J., B.A. Kimball, P.J. Pinter Jr., G.W. Wall, R.L. LaMorte, F.J. Adamsen, S.W. Leavitt, T.W. Thompson, and T.J. Brooks. 2000. CO2 enrichment and soil nitrogen effects on wheat evapotranspiration and water use efficiency. Agricultural and Forest Meteorology (104)2:85-100; Kimball, B.A., R.L. LaMorte, P.J. Pinter Jr., G.W. Wall, D.J. Hunsaker, F.J. Adamsen, S.W. Leavitt, T.L. Thompson, A.D. Matthias, and T.J. Brooks. 1999. Free-air CO2 enrichment (FACE) and soil nitrogen effects on energy balance and evapotranspiration of wheat. Water Resources Research 35(4): 1179-1190.). Thus, it appears likely that significant proportion of Earth's vegetation (half of the Midwest is covered by corn, a C4 plant much like sorghum, southern prairie grasses, many plants in Australia) will likely have reductions in ET due to the elevated CO2. The authors go on to cite modeling studies which suggest that elevated CO2 will have significant effects in some regions depending on senarios, which is appropriate. However, in spite of the FACE data in the literature and these modeling studies, the authors seem to discount the direct CO2 effects, and the last sentence states uncertainty. While of course there is uncertaintly associated with these effects, on the other hand there is far less uncertainty associated with the data on direct CO2 effects on ET of vegetation than there is on the indirect effects of elevated CO2 on future precipitation patterns, which forms the basis for the bulk of the climate change-hydrology studies. (Bruce Kimball, USDA, Agricultural Research Service)	
3-844	A	36	28	36	36	I would tend to agree with the first statement and I find the last one (lines 35-36) unclear.	

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						(Martin Savard, Geological Survey of Canada)	
3-845	A	36	28	36	29	This is wrong, especially over the oceans where most water vapor comes from even over land. (Kevin Trenberth, National Center for Atmospheric Research)	
3-846	A	36	32			Gordon and Famiglietti not in reference list (Bruce Kimball, USDA, Agricultural Research Service)	
3-847	A	36	44	36	50	For decision making a reference on the current degree of certainty of the changes in evaporation would be more appropiate than saying that more years are needed to draw reliable conclusions. Further, in line 48 is the terrestrial also the global evaporation or global evaporation means terrestrial plus oceans' evaporation? (Osvaldo Canziani, IPCC)	
3-848	A	36	45			Is Fig 3.8 showing actual or potential annual mean evaporation? (Robert Wilby, Environment Agency of England and Wales)	
3-849	A	36	49	36	50	Why do we need a few more years? (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	
3-850	A	36	49			Why do "we need [a] few more years to draw reliable conclusions…"? (Robert Wilby, Environment Agency of England and Wales)	
3-851	A	37	0			Section 3.4.4: If “very little research” then why is this section so long? (Kevin Trenberth, National Center for Atmospheric Research)	
3-852	A	37	1	37	6	maybe canncelled, since the results are extreme unreliable. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	
3-853	A	37	2			Figure 3.8. - same comments as for Figure 3.7. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	
3-854	A	37	3			What is the source of Fig 3.8? (Robert Wilby, Environment Agency of England and Wales)	
3-855	A	37	8			Section 3.4.3: This section has yet to be written. I would suggest that river ice, lake ice, reservoir ice, and permafrost be considered in addition to glaciers and snow. These topics were indentified as "insufficiently tackled" in the TAR (page 5, lines 14-17). (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-856	A	37	8			chpt. 3.4.3: The results of small glaciers in Bolivia seem very little in comparison with detailed studies in the European alps (e. g. Switzerland) (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	
3-857	A	37	13			Pierrehumbert (2005) missing from refs (Robert Wilby, Environment Agency of England and Wales)	

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3-858	A	37	15	37	19	Since Chapter 13 -Latin America- has a case study involving the tropical Andean glaciers, cross-referencing is highly recommended. (Osvaldo Canziani, IPCC)	
3-859	A	37	24	39	27	There seems to be considerable overlap between this section and section 3.2.4. I think this section could be shortened to focus only on the future impacts aspect. (Donald Burn, University of Waterloo)	It is reviewed
3-860	A	37	24	39	27	This section on groundwater calls for a deep check and, possibly, redrafting. In fact, to start with , it begins with the information that "there has been little research on the impacts of climate change on groundwater". However, this is not the only shortcoming. The situation is much more critical because of the remarkable lack of data series on groundwater levels with isophreatic and isopotencial curves, isosalinity maps, water quality and edaphic domains. Therefore, although it is plausible to speak about modeling (only applicable to highly developed countries), it is more valuable to tell decision makers to undertake the measurement and processing of the main groundwater variables. What would be the use of focused cases in this sectoral chapter? Further, careful reading of this section shows some contradictions. For instance in page 58, lines 37 to 39, it is said that the oceans' thermal expansion and increased melting of glaciers will spoil coastal aquifer water quality. In this segment reference is made to sea level rise and seawater intrusion; however, snowmelt also feeds aquifers, bringing better resilience to oppose salt water intrusion. Do we have reliable information on the potential developments? Are they similar in all places and cases?.. The argument the authors give in lines 37 to 39 of this same page 15, to some extent, is contradicted in lines 46 to 48, on the page, when it is suggested artificial groundwater resources mixing in order "to reduce sea water intrusion". The suggestion is also to consider regional cases in coordination with the respective regional chapters so to better point to regional needs and/or developments and clearly identify key regional vulnerabilities. (Osvaldo Canziani, IPCC)	Add: There has been little research on the impacts of climate change on groundwater but this is not the only shortcoming. The situation is much more critical because of the remarkable lack of data series on groundwater levels with isophreatic and isopotencial curves, isosalinity maps, water quality and edaphic domains. Therefore, although it is plausible to speak about modeling (only applicable to highly developed countries), it is more valuable to tell decision makers to undertake the measurement and processing of the main groundwater variables. However, snowmelt also feeds aquifers, bringing better resilience to oppose salt water intrusion. Consider te respective chapters.
3-861	A	37	24			Section 3.4.4. OK. At least the GCMs used are mentionned. Would benefit from having results from different GCMs or range of projections in text (Christel Prudhomme, Centre for Ecology and Hydrology)	OK
3-862	A	37	26	38	14	On groundwater modeling, the following papers could be cited: Liang X., Z. Xie, 2003: Important factors in land-atmosphere interactions: surface runoff generations and interactions between surface and groundwater. Global Planetary Change, 38,101-114. Liang X., Z. Xie, M. Huang, 2003: A new parameterization for	Add: Liang and Xie (2003) and Liang et al (2003) have explained the important factors in land-atmosphere interactions: surface runoff generations and interactions between surface

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						surface and groundwater interactions and its impact on water budgets with the variable infiltration capacity(VIC) land surface model, Journal of Geophysics Research,108(D16), 8613,doi:10.1029/2002-JD003090. Yang H., Z. Xie, 2003: A new method to dynamically simulate groundwater table in land surface model VIC, Progress in Natural Progress,13(11), 819-825. (Zhenghui Xie, Institute of Atmospheric Physics, Chinese Academy of Sciences)	and groundwater through modeling. Liang X., Z. Xie, 2003: Important factors in land-atmosphere interactions: surface runoff generations and interactions between surface and groundwater. Global Planetary Change, 38,101-114. Liang X., Z. Xie, M. Huang, 2003: A new parameterization for surface and groundwater interactions and its impact on water budgets with the variable infiltration capacity(VIC) land surface model, Journal of Geophysics Research,108(D16), 8613,doi:10.1029/2002-JD003090.
3-863	A	38	1	38	14	It is suggested to explain that because river flow gradients are lower than groundwater gradients (especially during the dry season) then in the same region the penetration of the sea interface into the rivers' streambeds is much further inland than into the aquifer. In cases where the streambed is not lined by clays, or at sites where there is a connection between the river bed and aquifer, the penetration of sea water interface may take place much further from the coastline inland than in regions with no rivers. (Arie S. ISSAR, Ben Gurion University of the Negev)	Add: Especially during the dry season the river flow gradients are lower than groundwater gradients then in the same region the penetration of the sea interface into the rivers' streambeds is much further inland than into the aquifer. In cases where the streambed is not lined by clays, or at sites where there is a connection between the river bed and aquifer, the penetration of sea water interface may take place much further from the coastline inland than in regions with no rivers.
3-864	A	38	1	38	14	Probably all true but rather indirect and difficult to follow (Nick van de Giesen, Delft University of Technology)	OK
3-865	A	38	2			This paragraph largerly repeats earlier material. (Robert Wilby, Environment Agency of England and Wales)	OK
3-866	A	38	5	38	9	I believe you've already stated this in a previous section (Cody Knutson, University of Nebraska-Lincoln)	OK?
3-867	A	38	5	38	10	L 5-10 repeats earlier material. See 3.2.4 p. 14 L23. (Kevin Trenberth, National Center for Atmospheric Research)	OK?
3-868	A	38	6	38	14	This material has already been presented earlier (p. 14). See comment No. 24.	OK?

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						(Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-869	A	38	15	38	32	This discussion is quite important and requires a bit more effort. Source of the discussion is not easily available. I would suggest addition of the discussion about the impact on recharge source, consequences of this impact, and maybe summary presentation of the results in the form of a table. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Table?
3-870	A	38	16	38	16	Provide brief backgound on the "global hydrological model" being referred to. For example, what are the basic processes being modelled, main assumptions, type of output, and the like. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-871	A	38	16	38	32	Model dependent. (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-872	A	38	24			Please add a reference after "temperature". (Martin Savard, Geological Survey of Canada)	Add: Chen et al, 2004.
3-873	A	38	24	38	25	Add the word " recharge" behind "groundwater". (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Add: recharge
3-874	A	38	29	38	29	This is contradicted by the earlier announcement that daily rainfall amounts will increase, even where total annual rainfall decreases. This is one of those points in the text where the authors seems to have a pendant towards the blackest of possible outcomes. (Nick van de Giesen, Delft University of Technology)	
3-875	A	38	30	38	32	Rising groundwater would change the falling trend of groundwater table in Northern China. You should mention these great economic benefits also for the Sahel zone. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Add: Rising groundwater would change the falling trend of groundwater table in Northern China.
3-876	A	38	34	38	40	Move these lines to part 3.2.9. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	OK
3-877	A	38	34	38	40	Repeats. (Kevin Trenberth, National Center for Atmospheric Research)	Check
3-878	A	38	42	38	44	See 3.2.5 (Kevin Trenberth, National Center for Atmospheric Research)	Check
3-879	A	38	44			Add "in this region" (Andreas Schumann, Institute of Hydrology, Water Resources Management and	Add: In this region

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						Environmental Engineering)	
3-880	A	38	46			What is "artificial groundwater resources mixture"? (Robert Wilby, Environment Agency of England and Wales)	Add: Such a mixing is achieved by mixing the saline groundwater from one well with relatively fresh groundwater from other wells.
3-881	A	39	4			Figure 3.9. Figure should bebigger. Imprve the resolution. Currently visibility does not allow any insight. Discussion of differences between different models should be added. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	OK
3-882	A	39	7			Define the acronym "WGHM" (Robert Wilby, Environment Agency of England and Wales)	Find the definition
3-883	A	39	13	39	15	The all paragraph should be corrected. The following is the suggested corrected version: Aquifers in rocks in semi arid regions are replenished by direct infiltration from surface flow into fractures, dissolution channels and pores as well as by floods (Issar and Gilad. 1982, Issar et al. 1984) , while alluvial aquifers are mainly recharged by floods therefore flood inundation areas are most etc. ....(Khiyami et al 2005). ..... (Arie S. ISSAR, Ben Gurion University of the Negev)	Add and correct: Aquifers in rocks in semi arid regions are replenished by direct infiltration from surface flow into fractures, dissolution channels and pores as well as by floods (Issar and Gilad. 1982, Issar et al. 1984) , while alluvial aquifers are mainly recharged by floods therefore flood inundation areas are most etc. ....(Khiyami et al 2005). ..... Find references: Issar and Gilad. 1982, Issar et al. 1984
3-884	A	39	13	39	21	References? “affected by climate change more significantly” than what? (Kevin Trenberth, National Center for Atmospheric Research)	Add: Chen et al (2004)
3-885	A	39	17	39	19	It is difficult to understand how an aquifer can not be affected by climate. It has to be clarified. (Sten Bergström, Swedish Meteorological and Hydrological Institute)	OK
3-886	A	39	17	39	19	Confined aquifers which are recharged over outcrops in regions which may be affected by changes in precipitation, that will cause changes in the hydraulic head in these regions, will transmit the change in head as pressure waves (moving very fast) to the confined parts of the aquifers (Sorek et al. 1992) (Arie S. ISSAR, Ben Gurion University of the Negev)	Add: Confined aquifers which are recharged over outcrops in regions which may be affected by changes in precipitation, that will cause changes in the hydraulic head in these regions, will transmit the change in head as pressure waves (moving very fast) to the confined parts of the aquifers (Sorek et al.

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							1992) Find reference Sorek et al. 1992
3-887	A	39	17			The statement "…, deep and especially confined aquifers are not in direct contact with the present-day hydrological cycle and they are very unlikely to be affected by climate." has many exceptions around the world, such as the lower Tuscany aquifer in Northern California. This aquifer, while very deep and confined at the Sacramento valley region, has its recharge areas along Sierra foothills that have water tables that are recharged by precipitation infiltration and runoff seepage. Hence, this aquifer is quite sensitive to climate conditions. (Levent Kavvas, University of California, Davis)	Add: This has many exceptions around the world, such as the lower Tuscany aquifer in Northern California. This aquifer, while very deep and confined at the Sacramento valley region, has its recharge areas along Sierra foothills that have water tables that are recharged by precipitation infiltration and runoff seepage. Hence, this aquifer is quite sensitive to climate conditions.
3-888	A	39	17	39	19	Some deeper and confined aquifers could be affected by climate (i.e., dryness in surface recharge zones) which could eventually affect artesian pressures, although there may be a considerable time lag. (Cody Knutson, University of Nebraska-Lincoln)	Add: Some deeper and confined aquifers could be affected by climate (i.e., dryness in surface recharge zones) which could eventually affect artesian pressures, although there may be a considerable time lag.
3-889	A	39	19	39	21	karstic aquifers have high specific yields (i.e. they have drainable permeabilities) (Arie S. ISSAR, Ben Gurion University of the Negev)	Add: Karstic aquifers have high specific yields (i.e. they have drainable permeabilities)
3-890	A	39	23		27	Point about desalination plants is dubious as presented ("will be used…"). They might be used…. (Rob de Loë, University of Guelph)	Change to: might be used
3-891	A	39	23			Instead of "will" you should use "can"! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	OK
3-892	A	39	27			Again, energy implications (Robert Wilby, Environment Agency of England and Wales)	OK
3-893	A	39				Figure 3.9: Add the word "Simulated" before "Impact". (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Add: Simulated
3-894	A	40	0			Section 3.4.5. Cf 3.2.5: redundant. Also fails to recognize that floods depend on at least the following: 1) Rain amount and time, 2) presence or not of snow, 3) condition of streams, rivers, ice dams, levels, 4) ground cover, soils, vegetation	Introduced in a shorter form

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						(deforestation), infiltration, 5) soil wetness, 6) topography, slopes, drainage, 7) human structures, levees, dams, reservoirs (Kevin Trenberth, National Center for Atmospheric Research)	
3-895	A	40	1		9	Some duplication… points made about floods and droughts were made earlier in the chapter (Rob de Loë, University of Guelph)	Duplication removed
3-896	A	40	3			Section 3.4.5: Somewhere in this section, it would be useful to discuss floods caused by river ice jams. This subject was identified as insufficiently covered in the TAR. Quantitative projections are scarce (only 1 reference known to me at this time, and it is "in press"), but there are a few qualitative projections that could be mentioned, i.e. Beltaos S. and Burrell, BC. 2003. Climatic change and river ice breakup. Can. J. of Civ. Eng. 30(1), 145-155. Prowse TD, Beltaos S. 2002. Climatic control of river-ice hydrology: A review. Hydrological Processes 16[4. March], John Wiley and Sons Ltd; 805-822. Prowse, T.D. and Bonsal, B.R. 2004. Historical trends in river-ice break-up: a review. Nordic Hydrology, 35(4-5), 281-293. There is also no discussion of flash floods, another topic that was identified as insufficiently covered in the TAR; however, I am not aware of any literature that makes specific projections as to future climate impacts on frequency/magnitude of flash floods. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Useful comment. We try to introduce.
3-897	A	40	3	42	8	As it happens in LAm, research papers and studies on floods, drought and their impact should be available for all IPCC regions. These should be cross-referenced with the corresponding regional chapters. A serious concern, calling for immediate action, is the one stemming from the UNFCCC Article 5 and the SBSTA - 18's request regarding the need for research and systematic observation. Socio-economic data as well as a number of the atmospheric and terrestrial's dominions data, as pointed out by GCOS, are badly needed. The solution of such serious shortcoming has to be spelt-out to decision makers. Since the water issue is of great importance to them, they must learn on their commitements to improve integrated water management and very particularly to face the three critical water issues: too much, too little, too dirty, as pointed out in the TAR-SYR. (Osvaldo Canziani, IPCC)	Yes, cross-regional / -sectional check needed (yet not feasible, because all chapters are being developed simultaneously and references to First Order Draft would be incorrect).
3-898	A	40	3			Section 3.4.5. Europé is in focus here, what about floods and droughts on other continents?	Many studies are available. But we quoted Milly et al. who offer global coverage.

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						(L. Phil Graham, Swedish Meteorological and Hydrological Institute)	
3-899	A	40	3			Section 3.4.5. Crucial to have some references here. Very few examples mention different GCMs and give range of impact. This is particularly important for intensity of daily precipitation, which is not well modelled by GCMs. Are the results obtained with some downscaling techniques? Again, how realistic is x4 CO2 level and which SRES emission can it be related to? (Christel Prudhomme, Centre for Ecology and Hydrology)	Reference to Milly et al. given
3-900	A	40	3	42	8	This sub-section needs more reference to other work to support arguments for increasing flood frequency in the future (one of the main findings in the Executive Summary). At the moment this is purely based on the concept that a warmer world will enhance the hydrological cycle and so must increase flooding. Uncertainty in this area remains large and changes in flood magnitude and frequency in the UK for example have been modelled as both positive and negative (Reynard et al, 2005; Kay et al, 2005a and b - these refs attached). (Nick Reynard, Centre for Ecology and Hydrology)	Good comment. Taken onboard
3-901	A	40	3			The EU STARDEX project focused specifically on downscaling future extremes. See: Goodess, C.M., Anagnostopoulo, C., Bardossy, A., Frei, C., Harpham, C., Haylock, M.R., Hundecha, Y., Maheras, P., Ribalaygua, J., Schmidli, J., Schmith, T., Tolika, K., Tomozeiu, R. and Wilby, R.L. 2005. An intercomparison of statistical downscaling methods for Europe and European regions - assessing their performance with respect to extreme temperature and precipitation events. Climatic Change, under revision. (Robert Wilby, Environment Agency of England and Wales)	Not directly relevant
3-902	A	40	6	40	6	Not so clear why droughts would also increase. Present drought often seem very regional, possibly induced by regional rather than global climate changes or simply persistent periods of drought. I can think of reasons why this would indeed be true but those are not given of hinted at in the text. (Nick van de Giesen, Delft University of Technology)	Decreasing precip and increasing temperature (see Fig. 3.10)
3-903	A	40	11	40	28	Tune with chapter 1 (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Yes, done
3-904	A	40	11	40	19	This seems to be a repetition (Nick van de Giesen, Delft University of Technology)	Section 3.2.5 deleted now.
3-905	A	40	11			This paragraph largerly repeats earlier material from p25. (Robert Wilby, Environment Agency of England and Wales)	Section 3.2.5 deleted now.
3-906	A	40	16	40	35	Model dependent, needs to be synthesized. (Kevin Trenberth, National Center for Atmospheric Research)	
3-907	A	40	27			A five-fold increase of probability says nothing without a specification of the	This is the principal message from the

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						existing probability. (Is it 1 or 10 percent?) (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	reference assessed. Interested readers would go to the paper in NATURE.
3-908	A	40	30	40	34	These results are intriguing, and some amplification would be very helpful. For instance, what are the main regions covered by the 16 basins ? How were the future flood peaks assessed ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	No way to discuss details of a single paper. Interested readers would go to the paper in NATURE.
3-909	A	40	30	40	35	The extreme changes of the return period of the 100 years flood (into 2 or 5 years) seems to be very unrealistic for the background of uncertainties of changes of extreme precipitation. Please discuss this result with regard to page 29! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	No way to discuss details of a single paper. Interested readers would go to the paper in NATURE.
3-910	A	40	34	40	35	"…the likelihood that these changes are due to natural climate variability is small". This statement is a bit confusing. Is it correct to infer that the changes that are projected under a 4XCO2 scenario are unlikely to occur as a result of variability under 1xCO2 conditions ? Also, what is a "small likelihood" ? 1 in 100 ? 1 in 1000 ? other ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Deleted
3-911	A	40	34	40	35	Leave out (they are all modeling results). (Nick van de Giesen, Delft University of Technology)	All results stem from modelling.
3-912	A	40	37	40	45	in fig.3.10, there is only change in recurrence of 100-year droughts and not 100-year flood, so "In the critical regions, events with an intensity of today's 100 year floods … may recur every 10-50 years by the 2070s" should be either revised or added a new figure (Chunzhen Liu, Water Information Center,MWR)	Revised.
3-913	A	40	37			Are flood frequency studies based on changes in unsecure prediction of monthly precipitation values an acceptable methodology? (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	No other, process-based tools known to the writers.
3-914	A	40	37	40	45	Paragraph not well structured, with floods and droughts results mixed together in text. Methodology must be clarified (Christel Prudhomme, Centre for Ecology and Hydrology)	We tried to improve the structure.
3-915	A	40	37	40	45	Same comment as for line 30 - 35. Again the author neglects the great uncertainties estimating changes of extremes. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	More careful writing.
3-916	A	40	37	40	45	The effect of climate change on design floods of large dams will depend on the watershed evaluated. The main differenced are caused by the different factors	Regionally varying impacts.

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						responsible for causing the flood event. Where rain is the dominant cause of flooding there is a risk of design floods increasing in magnitude due to climate change. However where snow is the main cause of flooding the design floods remain the same or decrease. This is caused by the decreasing amount of snow accumulated during the winter.: Veijalainen, N. and Vehviläinen, B. 2004. Climate change and design floods in Finland. XXIII Nordic Hydrological Conference, Tallinn, Estonia,8-12 August 2004, NHP report no.48. ISBN 9985-56-921- 0 (Bertel Vehviläinen, Finnish Environment Institute)	
3-917	A	40	38			Lehner reference is with co-authors in the list? There are two 2005 references??? (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Ordered
3-918	A	40	43			Monthly data are not adequate. (Kevin Trenberth, National Center for Atmospheric Research)	Proxy for large rivers
3-919	A	40	45	40	45	Leave out. (Nick van de Giesen, Delft University of Technology)	
3-920	A	40	47			"dynamic demographic growth" = "population growth"? (Robert Wilby, Environment Agency of England and Wales)	Yes
3-921	A	41	1	41	3	Very true, and vice versa, but not so relevant in climate change context. Why not also mention that potential increases in riverflow may diminish impact of withdrawals? (Nick van de Giesen, Delft University of Technology)	Not so relevant in the section on extremes
3-922	A	41	5			Figure 3.10 Improve resolution. Discuss the difference between the models. There is a considerable difference in results between the models. What can be concluded based on this presentation???? Reference should be cleared (see comment above). (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Cannot discuss this figure in more detail. Exact references given.
3-923	A	41	6			Figure 3.10. Results seem downscaled (finer spatial scale than GCM): how? Must be clarified in text. Is the map obtained as difference between modelled current and future? Or as difference between observed and future (in that case, need to see the error in modelling current) (Christel Prudhomme, Centre for Ecology and Hydrology)	Cannot discuss this figure in more detail. Exact references given.
3-924	A	41	6			Figure 3.10: What was the basis of this assessment of changes of a 100 years drought? Were probabilistic simulations used or how these shifts were estimated? Is (Lehner, 2005) a general accepted statement? (It is not given in the references, only Lehner et al. with a submitted paper (I would like to review them)) (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Cannot discuss this figure in more detail. Exact references given.

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3-925	A	41	6			Fig 3.10: what about aerosols? (Kevin Trenberth, National Center for Atmospheric Research)	Cannot discuss this figure in more detail. Exact references given.
3-926	A	41	16	41	17	Growing summer temperature sentence was not completely clear. (Harvey Hill, Prairie Farm Rehabilitation Administration)	
3-927	A	41	16	41	17	The statement is exactly the same as the statement in lines 12-14 (Batima Punsalmaa, Institute of meteorology and Hydrology)	Revised accordingly
3-928	A	41	17	41	19	This statement shows a poor understanding of groundwater recharge processes. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Yes. No action needed.
3-929	A	41	18			Why? References? (Kevin Trenberth, National Center for Atmospheric Research)	Given
3-930	A	41	19			For more on joint probability extremes, see again: Sivapalan et al. (2005) (Robert Wilby, Environment Agency of England and Wales)	Not urgently necessary addition.
3-931	A	42	1	42	4	The increase in summer drying "could" lead to a number of adverse impacts (unless offset by mitigation actions or other feedback mechanisms). "Increased damage to building foundations caused by ground shrinkage" is a more obscure problem compared to the other issues cited (unless you include land subsidence issues along with ground shrinkage around buildings). Other important effects could be reduced recreational opportunities; fish and wildlife losses, etc. (see http://drought.unl.edu/risk/impacts.htm for a list of typical drought impacts). (Cody Knutson, University of Nebraska-Lincoln)	Reflected in new text
3-932	A	42	1	42	4	One important impact associated with the line of thinking in this paragraph is on the health of open rangeland and pastures used for grazing livestock. This is often ignored when talking agricultural drought, yet it has major ramifications to livestock producers. (Mark Svoboda, National Drought Mitigation Center)	Valuable comment. Yet, space restrictions apply
3-933	A	42	1	42	4	Deals only with adverse impacts, what about positive impacts? Like more fine days for playing golf or cricket? (Kevin Trenberth, National Center for Atmospheric Research)	This is not a proper section for such a remark. Nobody likes extremes.
3-934	A	42	8	42	8	And are there also areas where people will be delighted with effects of climate change? (Nick van de Giesen, Delft University of Technology)	This is not a proper section for such a remark. Nobody likes extremes.
3-935	A	42	11			Paragraph 3.4.6 can be reduced in size (+/- 50%) (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	will be reduced
3-936	A	42	11			Section 3.4.6. A discussion of rainfed agriculture is missing. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Rainfed agriculture is covered in Chapter 5
3-937	A	42	11			It seems as though this section is missing a discussion of the possible impact of	Example given in line 49

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						climate warming on sustaining water supplies in regions where water availability depends on glacier fed rivers and where the glaciers are rapidly decreasing in mass. See lines 19-30 page 19 of Chapter 1 of WG2. Citing Janssens et al 2003 Janssens, I. A. et al., 2003 Europe's terrestrial biosphere absorbs 7 to 12% of Europe's Anthropogenic Emissions. Science 300(5625): 1538. (Thomas Huntington, U.S. Geological Survey)	
3-938	A	42	11	47	26	Section 3.4.6: seems like a series of anecdotes and no assessment. (Kevin Trenberth, National Center for Atmospheric Research)	Will be improved
3-939	A	42	13	47	26	A total of 222 written lines, a figure and a table are devoted to the sub-section "Water availability and use". It is a too detailed and extended section which text could be improved by reducing its extension by at least a half. Coordination with the sectoral (4) and the regional chapters will serve the purpose. (Osvaldo Canziani, IPCC)	Length will be reduced.
3-940	A	42	13	42	31	Suggest to add the following:Based on the interpretation of historical time series of proxy data, it can be forecasted the warmer global climate will cause higher summer precipitation rates and floods in the southern part of the Colorado basin while in its northern part the winter and summer rates of precipitation will be less. These scenario may change due to el Nino events. With regard to California it can be forecasted that in general this region will have more sumer rains entering from the Pacific but winters will be drier. During periods of el Nino torrential winter storms may occur (Issar 2003 p.101). (Arie S. ISSAR, Ben Gurion University of the Negev)	Not possible to include due to space constraints (section needs to be reduced in length)
3-941	A	42	15	42	16	Garbled, makes no sense. (Kevin Trenberth, National Center for Atmospheric Research)	Due to inconsistent inclusion of references (here, Endnote style was used by author but then the text was not handled with Endnote)
3-942	A	42	21	42	21	"selected climate model": identify model. Also, indicate whether discharge is predicted by the GCM itself or by coupling a GCM with a Hydrological model. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Inserted: NCAR PCM; using basin-scale hydrological models and downscaling of GCM climate change output
3-943	A	42	21			A selected climate model' plus rest of paragraph: which model? Should present range of results. Rest of section good quality, with range of results presented (Christel Prudhomme, Centre for Ecology and Hydrology)	See notes of comment 3-492; o.k.
3-944	A	42	21			As the impacts are related to a "selected" climate model how large is the uncertainty of such an assessment? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	it will be clear to the reader from what he learned in section 3.3 and from lines 25-37 here that uncertainty is high.
3-945	A	42	22			Simplify "around 2020, 2050 and 2080" to "beyond 2020"?	accepted

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						(Robert Wilby, Environment Agency of England and Wales)	
3-946	A	42	25	42	30	Leave out. (Nick van de Giesen, Delft University of Technology)	No, necessary to show uncertainty.
3-947	A	42	32	42	34	The first sentence of this para should be in the Executive Summary. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	It is in the Executive Summary.
3-948	A	42	32	42	37	This paragraph seemed quite awkward and may be difficult to understand for many readers. (Harvey Hill, Prairie Farm Rehabilitation Administration)	Reformulated.
3-949	A	42	39	42	43	This should be under vulnerability assessment (Nick van de Giesen, Delft University of Technology)	The whole section 3.4.6 will be moved to section 3.5 Costs and other socio-economic aspects
3-950	A	42	46			Add "…strong negative impact through greater intermittency of supplies". (Robert Wilby, Environment Agency of England and Wales)	No space for this addition
3-951	A	42	48	42	49	What about this case: "Droughts occur more frequently in the West and usually last longer there, but the droughts of 1998 through 2000 have demonstrated the vulnerability of eastern [U.S.] states to severe and extended periods of low rainfall. Yet the West is currently better equipped to manage water supplies during extended periods of water shortage because of large investments in water storage and transmission facilities. Precisely because the eastern states have fewer droughts, the region is generally less prepared to mitigate and respond to its effects." (Wilhite, 2001 at http://forum.ra.utk.edu/Archives/Spring2001/wilhite.html). In some cases, humid areas may be less able to withstand the effects of drought because of reduced coping capacity. For example, the western United States has an an allocation system for low river flows (prior appropriation) while the eastern U.S. has shared riparian rights that can cause problems during extended periods of drought. (Cody Knutson, University of Nebraska-Lincoln)	Included that humid areas generally not prepared for drought, e.g. the Eastern US as compared to the Western US (Wilhite, 2001)
3-952	A	42	50			What is basis for this? These are not predictions but scenarios. (Kevin Trenberth, National Center for Atmospheric Research)	Predictions are never possible, everything is a scenario which should be clear to the reader after reading 3.3.1 in particular. And the term “may be” is used.
3-953	A	43	1	43	7	Model dependent and scenario dependent. These are not predictions. (Kevin Trenberth, National Center for Atmospheric Research)	See note to comment 3-952
3-954	A	43	2	43	7	This is a very important paragraph. However the drought conditions observed nowadays in Argentina and Brazil, adversely affecting new maize and soybean crops, even in river basins of their cropping regions, calls for the best possible writing regarding Rosenzweig's 2004's projections. For instance, in line 2 it would be better to say: "water supply for irrigation would	Study of water supply for large irrigation areas deleted due to space constraints.

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						not decrease, etc" instead of saying "does not" (Osvaldo Canziani, IPCC)	Accepted.
3-955	A	43	6	43	7	Leave out. (Nick van de Giesen, Delft University of Technology)	No, as this sentence is necessary to understand the scenario result.
3-956	A	43	7			Also of interest will be recent work on changes in water availability in northwest England under the 4 IPCC SRES scenarios (A1, A2, B2, B1) and implications for future management. Details can be found in: Fowler, H.J., Kilsby, C.G. and Stunell, J. Modelling the impacts of projected future climate change on water resources in northwest England. Hydrology and Earth System Science, in press (Hayley Fowler, Newcastle University)	Maybe too local given the space constraints.
3-957	A	43	9			Figure 3.11. Improve resolution. Discuss the difference between the climate models - some areas of Germany and Russia are showing the difference from -25% in the case of one model to +25% in the cse of the other model??? It will be also important to say soemthing about the tool used for these calculations - WaterGAP. Knowledge of modeling assumptions for example may help in the interpretation of the results. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Fig. 3.11 deleted.
3-958	A	43	10			Fig. 3.11 would be easier to "read" if it were prepared in colour. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Fig. 3.11 deleted
3-959	A	43	10			Place figure 3.11 after its first citation in text (p. 44, L4) (Martin Savard, Geological Survey of Canada)	Fig. 3.11 deleted
3-960	A	43	10			Fig 3.11 features huge differences, so how can you have confidence? (Kevin Trenberth, National Center for Atmospheric Research)	Fig. 3.11 deleted
3-961	A	43	13	43	31	In this paragraph the assertion is made that climate change may reduce water stress in many river basin regions. Later in the paragraph two points are made that indicate that might not be the case the second point in the Arnell reference lines 30-31 indicates that very populous regions of Asia do benefit. Why is point 2 a contradiction of the initial assertion? (Harvey Hill, Prairie Farm Rehabilitation Administration)	Cannot be connected to lines 13-31 on page 43
3-962	A	43	18			Almost all references quoted are different in the list (with coauthors). (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Endnote problem, will be resolved in SOD
3-963	A	44	1			The results cited here can hardly be reconstructed from Fig. 3.11. To characterize the temporal variability of water supply, the PADED-coefficient proved to be an adequte indicator. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	o.k.

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3-964	A	44	4	44	10	The uncertainties associated with the results depicted Fig. 3.11 are disconcerting. Not only is there large discrepancy between the outputs of the two applied models, the assumed climatic variables are deficient in variability. It may be better to delete the figure and simply state that there is an indication of possible increase of Q90 in parts of Europe, and cite the appropriate reference. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Fig. 3.11 deleted
3-965	A	44	5			Reword "latter statistical monthly low flows" (Robert Wilby, Environment Agency of England and Wales)	Accepted
3-966	A	44	13			What about PDSI: see Dai et al 2004 for instance. (Kevin Trenberth, National Center for Atmospheric Research)	Palmer Drought Severity Index does not relate human water demand to water resources, which is the topic of this section
3-967	A	44	15	44	20	Conclusion presented here is indicating the need for a completely different modeling tool. One potential approach is available in 109. Simonovic, S.P., (2002) "World Water Dynamics: Global Modeling of Water Resources", Journal of Environmental Management,66(3):249-267. (in the paper other work of importance is referenced). (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	This approach would not help the problem of having to be spatially explicit for meaningful results.
3-968	A	44	21	44	23	I wonder whether the quoted numbers are actually accurate to 1 million. If not, suitable rounding off should be applied. The same applies to the numbers contained in Table 3.3. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Leave it as it as this is the way it is presented in the papers and the accuracy per scenario is hard to define but certainly low.
3-969	A	44	21	44	24	The sentence starting, "In the A2 scenario…" leaves out the larger story, which is captured better in Table 3.3, namely, the total population living under water stressed conditions will decline due to climate change. If estimates for the population moving into the water stressed category are retained, then the estimates should also be provided for the population that moves out of that category. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	The larger story is that the numbers in Table 3 are misleading if not carefully interpreted, as is tried to explain in lines 28-31. Moving out of stress: Would make presentation even more lengthy and complicated.
3-970	A	44	28	44	31	"This is misleading…": This discussion seems to attach far too much importance to questionable material. I think that much of the problem lies in the very large uncertainty associated with the projections descibed in Table 3.3. The most that can be said in this particular instance is that model-based predictions of water stress indices for the 2050s are inconclusive because two different authors have obtained contradictory results. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Almost all computations of future impacts of climate change on sectors are highly uncertain. The table illustrates the range of uncertainty, but shows that the millions to billions of people are affected.
3-971	A	44	28			Replace the sentence starting with "This is misleading…" with the following: "HOWEVER, increases in runoff mainly occur during high flow seasons, and may	Accepted.

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						not alleviate dry season problems if the extra water is not stored. NOTABLY the basins that apparently benefit from climate change, WHILE limited in NUMBER, ARE IN THE MOST populous parts of the world, mainly in east and southeast Asia." The sentence as it currently stands seems to suggest that the finding in Arnell (2004) should be discounted somewhat because the basins potentially benefiting from CC would be quite populous. Why? (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-972	A	44	34	44	38	The heading of the table is far too long. It should simply state what the table is about. Discussion of the various numbers that appear in the Table belongs in the text. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Accepted.
3-973	A	44	34			Table 3.3: a number for 1995 is missing in the second column. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	See comment 3-976.
3-974	A	44	34	44	40	There appears to be an error in this table because it shows that according to Arnell, fewer people will be living in water stressed areas with climate change than without climate change. (Lenny Bernstein, IPIECA)	That is not an error.
3-975	A	44	34			Table 3.3: What about autonomous adaptation: won't people move away? (Kevin Trenberth, National Center for Atmospheric Research)	Should not be covered here, rather in 3.6
3-976	A	44	34			Table 3.3. The data for 1995 appear to have been shifted right by one column. (Robert Wilby, Environment Agency of England and Wales)	Accepted.
3-977	A	44	38			Table 3.3 contains problems with references mentioned earlier. Since the assumptions on future population distributions are very important I would suggest that they are presented and discussed in the text. How are these assumptions made? What are the implications? (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Already discussed (shortly), no space to elaborate
3-978	A	45	3	45	50	So what is the assessment? (Kevin Trenberth, National Center for Atmospheric Research)	Section 3.4.6 is restructured and moved to section 3.5.
3-979	A	45	10			"increased precipitation" if it occurs? (Kevin Trenberth, National Center for Atmospheric Research)	Reformulated.
3-980	A	45	11			How large is the global area with decreasing water stress? As increasing precipitation reduce it on 53 - 83 % it is interesting to know its total percentage. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Reformulated.
3-981	A	45	13			Again, a possible headline message for policy-makers that increased water stress is mainly linked to domestic water consumption driven by income growth, not climate	However, these studies did not take into account the impact of increased climate

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						change. (Robert Wilby, Environment Agency of England and Wales)	variability, and stress was defined based on annual values only, so the conclusion is uncertain
3-982	A	45	15			It is suggested to cancel out the word "Please". (Osvaldo Canziani, IPCC)	Accepted
3-983	A	45	19			This paragraph needs to be internally consistent. Either climate change will, or will not, lead to greater irrigation water use. (Robert Wilby, Environment Agency of England and Wales)	Not known yet, however.
3-984	A	45	21	45	22	For "Higher temperatures alone" this may be true but we see general decrease in pan evaporation (see references there) (Nick van de Giesen, Delft University of Technology)	But I understand that the decrease of pan evaporation does not necessarily mean the PET is decreasing, but it may be a certain measurement artefact in drier areas (Barnett et al. 2005).
3-985	A	45	25	45	26	This statement can only be true under non-phytotoxic conditions (Savard et al, 2004, 2005). As we know the emission of pollutants released through fossil fuel combustion will increase in their associated toxics as well (e.g. ozone). Ozone has a far reaching capacity and affects large urban aureoles by diminishing plant growth (stomatal conductance). (Martin Savard, Geological Survey of Canada)	Not an important point here.
3-986	A	45	26			But evaporation and drying still occurs. (Kevin Trenberth, National Center for Atmospheric Research)	Certainly.
3-987	A	45	33			What is the impact of climate change? Are these impacts known by Döll or assumed? What assumptions were used? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	The modelling assumptions are given in the paragraph.
3-988	A	45	36			Instead of "will" you should be use "could be shifted". (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Accepted.
3-989	A	45	36			Scenario not prediction. (Kevin Trenberth, National Center for Atmospheric Research)	See note to comment 3-988.
3-990	A	45	40	45	43	Since the author states there is little correlation between precip and green house gase emissions it is not surprising that the lower emission scenario B2 is the one that produces the highest global net irrigation requirements. Why is this relationship so obvious? (Harvey Hill, Prairie Farm Rehabilitation Administration)	Reformulated.
3-991	A	45	45	45	50	It will be important to identify why is the assumed increase in domestic and industrial water use larger than the increase in irrigation water use. If we see	Sentence added: This is based on the idea that the value of water is much higher for domestic

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						increase in droughts (in some regions) I would assume more water will be needed for irrigation????? (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	and industrial uses, which is particularly true under conditions of water stress.
3-992	A	45	50			This statement has to be related to the large differences in the amounts of water used by these different groups of users ! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Mentioned at the end of paragraph.
3-993	A	46	2			year 2000… may be it is 2020 (Batima Punsalmaa, Institute of meteorology and Hydrology)	Is correct as is.
3-994	A	46	14			be 4% ---by 4% (Batima Punsalmaa, Institute of meteorology and Hydrology)	Sentence was deleted anyway.
3-995	A	46	18			Dated and unrealistic. (Kevin Trenberth, National Center for Atmospheric Research)	K. Trenberth was asked for clarification and references, and caveat on neglect of the impact of climate variability was added.
3-996	A	46	20	46	23	This is absurd and highly dependent on assumptions. (Kevin Trenberth, National Center for Atmospheric Research)	K. Trenberth was asked for clarification and references, and caveat on neglect of the impact of climate variability was added.
3-997	A	46	34	46	45	Reference on the decommissioning of large dams (see page 25 line 44) and the new criteria regarding small hydropower stations, will assist decision making, particularly in developing countries (ref.) (Osvaldo Canziani, IPCC)	No space to discuss this.
3-998	A	46	34			Subtitle??? The paragraph is talking about hydropower. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Changed to hydropower.
3-999	A	46	35	46	37	This sentence ought to go into the Executive Summary. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Sentence deleted as it was obviously misleading.
3-1000	A	46	35			Is this a prediction? (Kevin Trenberth, National Center for Atmospheric Research)	No, an assumption about the future as written.
3-1001	A	46	43			"will suffer" is this a prediction? (Kevin Trenberth, National Center for Atmospheric Research)	A modelling result only, as can best be done about the future.
3-1002	A	46	47	47	26	It may be of interest to mention in this sub-section (Water requirements of aquatic ecosystems) a recent study indicating that the aquatic habitat of a major Canadian river delta is projected to decline as a result of less frequent ice-jam flooding in the 2080s (Beltaos, S., Prowse, T. Bonsal, B., MacKay, R., Romolo, L., Pietroniro, A., and Toth, B. 2006. Climatic effects on ice-jam flooding of the Peace-Athabasca Delta. Hydrological Processes, in press).	Added.

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						(Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-1003	A	46	47	47	26	"Water requirements of aquatic ecosystems" is an important section, but the topic is handled too quickly. For example, what are the implications of anticipated negative impacts on aquatic ecosystems for human systems that depend on these? Also, while the three examples are fine, the rationale for choosing these rather than other ones is unclear (e.g., were they simply studies at hand, or do they illustrate the most likely kinds of impacts)? (Rob de Loë, University of Guelph)	Beltaos et al 2006 reference (comment 3-1002) added.
3-1004	A	46	47	47	7	There are many more studies on temperature effects on aquatic ecosystems; please indicate this by linking to the Ecosystems chapter, if appropriate. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Done.
3-1005	A	46	47			Note that the water requirements for aquatic ecosystems are regulated by complex legislation such as the EU Water Framework Direct (which in this case, does not explicitly recognise climate change despite the programmes of measures extending into the 2020s). See: Wilby et al. (2005). (Robert Wilby, Environment Agency of England and Wales)	Not covered due to space constraints.
3-1006	A	46	48			"If" What about "if not"? (Kevin Trenberth, National Center for Atmospheric Research)	Replace "if" by "where"
3-1007	A	47	1	47	7	This is vulnerability not prediction. (Kevin Trenberth, National Center for Atmospheric Research)	The whole section 3.4.6 is moved to 3.5 Costs
3-1008	A	47	5	47	7	Held and Soden (2000) is a good reference to cite that provides the theoretical underpinning for the argument that a warmer climate will likely result in a wetter climate. Huntington (In Press) provides a review of the evidence that supports an ongoing intensification of the global hydrologic cycle. Held, I.M., Soden, B, J., 2000. Water vapor feedback and global warming. Annual Review of Energy and the Environment 25, 441-475 Huntington, T. G. In Press, Evidence for intensification of the global water cycle: review and synthesis, Journal of Hydrology (Thomas Huntington, U.S. Geological Survey)	Misplaced comment, not related to text.
3-1009	A	47	7			Also see results of: Walsh, C. and Kilsby, C.G.: Impacts of climate change on flow regime affecting Atlantic salmon. Hydrol. Earth Syst. Sci., in press. They found that climate change (under SRES A2) will decrease the percentage time the ideal minimum flow requirements will be met for various life stages of Atlantic Salmon. For example, In the case of suitable flow depth for spawning activity again at the outlet of the catchment, the percentage time may decrease from 100% under current conditions to 94% in the future.	Reference included.

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						(Hayley Fowler, Newcastle University)	
3-1010	A	47	9	47	21	Leave out (too detailed) (Nick van de Giesen, Delft University of Technology)	Condensed.
3-1011	A	47	26			A further key determinant of future ecological status will be the direct and indirect effects of climate change on hydromorphology. See: Sear, D.A. and Newson, M.D. 2003. Environmental change in river channels: a neglected element. Towards geomorphological typologies, standards and monitoring. Science of the Total Environment, 310,17-23. (Robert Wilby, Environment Agency of England and Wales)	Not covered due to lack of space and appropriate references. Provided reference not appropriate (is on monitoring in general, not on effects of climate change on hydromorphology)
3-1012	A	47	29	49	8	As mentioned before, there are not only bacterial, agrochemical, industrial, liquid and solid wastes, salinization, silting up in general, affecting the water quality. The dilution of natural soil containing heavy metals is important as it is also very important the effect of transboundary pollution with the associated acidic deposition. Further the BAPMon (Background Air Pollution Monitoring Network), developed by the WMO, has initiated some decades ago the measurement of the acidity in deposition/ and precipitation events. The increasing CO2 concentration in the atmosphere has already alerted ecologist and ocean specialists on the deleterious effects of the seawater increasing acidification. This means that this sub-section should at least mention the potential adverser effects of CO2 increasing atmospheric concentrations on fresh water quality. The already mentioned effects of heavy metals contamination, particularly on groundwater shall be also referred here (R. Clarke and J. King, The Atlas of Water, Earthscan, 2004). Cross-reference with sectorial chapters, in this case Chapter 8 HH and the regional one is necessary. (Osvaldo Canziani, IPCC)	Partly considered According to literature freshwater acidification is linked to SOx and NOx and not to atmospheric CO2 , anyway acidification due to other causes was considered in text.
3-1013	A	47	29			For a discussion of climate change impacts on environmental standards, see Crane et al (2005) and refs therein (Robert Wilby, Environment Agency of England and Wales)	OK, considered
3-1014	A	47	31	47	39	Repeated (Nick van de Giesen, Delft University of Technology)	OK
3-1015	A	47	41			What about regions where rainfall doesn't increase. (Kevin Trenberth, National Center for Atmospheric Research)	OK, considered
3-1016	A	47	43	47	43	add "Fukushima et al., 2000" into the parentheses. Fukushima, T., Ozaki, N., Kaminishi, H., Harasawa, H., and Matsushige, K. (2000) Forecasting the changes in lake water quality in response to climate changes, using past relationships between meteorological conditions and water quality. Hydrological Processes, Vol. 14, 593-	OK, considered

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						604. (Takehiko Fukushima, University of Tsukuba)	
3-1017	A	47				Section 3.4.7. Is there overlap with the Ecosystems chapter? If so, this section can be significantly shortened. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Considered, and agreement was reached between authors on chapter 4 and 3 . In chapter 3 effects on waster quality will be mentioned and explained indicating shortly effects on ecosystems. Emphasis will be made in changes that implies water management needs.
3-1018	A	48	2			"will pose" but not if mitigated. (Kevin Trenberth, National Center for Atmospheric Research)	OK, considered
3-1019	A	48	4	48	16	Element of uncertainty is omitted. Say how many and which GCMs are used to drive conclusions, and present range of changes. (Christel Prudhomme, Centre for Ecology and Hydrology)	Reworded and information requested presented when available.
3-1020	A	48	7			Most of this section should be in the previous "ecosystems section" as these are not impacts on water quality. (Hayley Fowler, Newcastle University)	Chapter 7 will deal with ecosystem, but aspecst concerning water quality management stratetiges, that might affect ecosystems, was decided to include it here
3-1021	A	48	7	48	16	Lots of "will" as if predictions. Should be posed as risk. (Kevin Trenberth, National Center for Atmospheric Research)	OK, considered
3-1022	A	48	7	48	26	Repeated (Nick van de Giesen, Delft University of Technology)	OK
3-1023	A	48	18	48	20	Rewrite. (Kevin Trenberth, National Center for Atmospheric Research)	OK, considered
3-1024	A	48	20	48	23	No, it is precipitation minus evaporation. (Kevin Trenberth, National Center for Atmospheric Research)	OK, considered
3-1025	A	48	31			Doesn't this depend on whether there is a treatment plant? (Kevin Trenberth, National Center for Atmospheric Research)	OK, considered and explanation why water treatment plants presence are not determinant to control biological water quality problems
3-1026	A	48	33			Insert a new sentence after the period on line 35 as follows: "On the other hand, future socio-economic conditions are likely to be as, if not more, important in determining future public health consequences resulting from potentially higher microbial activity due to any climate change." (Goklany 2005b) (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Several reference Goklany 2005 were consulted but the information cited in here was not found
3-1027	A	48	33			Not "variable" but "stressor" (Kevin Trenberth, National Center for Atmospheric Research)	OK, considered
3-1028	A	48	35			Explain "due to a minor capacity"	OK, considered

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						(Robert Wilby, Environment Agency of England and Wales)	
3-1029	A	48	39			The Millennium Development Goals are targeted to be met by 2015. Given that, success or failure in meeting them have little or nothing to do with climate change, because the effcts of CC should still be pretty minimal by then. See Goklany (2005, 2005b). (Indur Goklany, Office of Policy Analysis, Department of the Interior)	OK
3-1030	A	48	41	48	42	Temperature effects on lakes are not only seen in polar regions; this sentence is misleading here. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	Paragraph was deleted
3-1031	A	48	43	48	48	Not helpful: “positive and negative effects”?? “could induce” or not? (Kevin Trenberth, National Center for Atmospheric Research)	Paragraph was deleted
3-1032	A	49	0	50		Section 3.4.8: Needs references, “average rainfalls are not on the rise, see WG I chapter 3, the results here are model dependent and the models are dated. Where is the assessment? (Kevin Trenberth, National Center for Atmospheric Research)	THIS BELONSG TO SECTION 3.4.8 NOTE: THERE ARE TWO TEXTS WITH DIFFERENT LINE NUMBERING
3-1033	A	49	1	49	1	The present percentage should also be stated here, so that the reader can appreciate the effect of climate change. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	THIS BELONGS TO SECTION 3.4.8
3-1034	A	49	1	49	8	This part seems to be misplaced here. (Dieter Gerten, Potsdam Institute for Climate Impact Research)	THIS BELONGS TO SECTION 3.4.8 EROSION
3-1035	A	49	6	49	6	Is the word convenience used appropriately in this sentence? (Harvey Hill, Prairie Farm Rehabilitation Administration)	OK; considered
3-1036	A	49	11	50	30	Coordination with Chapters 4, 5 and regional is suggested. (Osvaldo Canziani, IPCC)	
3-1037	A	49	11			Tune with 3.2.8 (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	
3-1038	A	49	11			Section 3.4.8. Good overall, with results related to various GCMs and uncertainty mentionned. (Christel Prudhomme, Centre for Ecology and Hydrology)	
3-1039	A	49	13	49	15	Not sure statement is right. Doubt in precipitation projections! (Christel Prudhomme, Centre for Ecology and Hydrology)	
3-1040	A	49	13	50	30	Erosion very difficult to assess. It is really about a very few very intensive storms. Reduce or leave out. (Nick van de Giesen, Delft University of Technology)	
3-1041	A	49	15			It is not erosion per se, but the potential for erosion that changes with increased precipitation intensities. (Robert Wilby, Environment Agency of England and Wales)	

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3-1042	A	49	20	49	45	Indicate the scenario(s) used in each case. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-1043	A	49	30	49	33	How many GCM´s were used to make this statement? Is it based on a good knowledge about changes in precipitation intensities or just on an assumption of their changes? What means an "increase of erosion on the order of 60 percent" in this humid environment. Maybe these lines could be deleted without loosing very important information. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	
3-1044	A	49	35	49	45	Repeated (Nick van de Giesen, Delft University of Technology)	
3-1045	A	49	37			UK Hadley Centre model (HadCM3) acronym already defined on line 20 (Robert Wilby, Environment Agency of England and Wales)	
3-1046	A	49	41	49	43	This is not a surprise, but the statement of Pruski and Nearing (cited at page 21, line 31 to 34 was much more specific! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	
3-1047	A	49	49			Ditto (Robert Wilby, Environment Agency of England and Wales)	
3-1048	A	50	0	52		Section 3.3.9:There are 3 other possibilities other than rise in temperature and decrease in precipitation. This is a recitation of cases and needs an assessment. (Kevin Trenberth, National Center for Atmospheric Research)	
3-1049	A	50	6	50	7	Makes an important point about land use (Harvey Hill, Prairie Farm Rehabilitation Administration)	
3-1050	A	50	16	50	19	Regarding erosion and soil loss, did these studies consider the potential for no- or low-tillage soy crops? Use of such "conservation tillage" has advanced substantially since the introduction of bioengineered crops. According to a 2001 survey done by the American Soybean Association (2001) , because of the increased popularity of Roundup Ready (herbicide tolerant) soybean, 73 percent of the soy farmers were leaving more crop residue on the soil; and soy acreage that was "no till" doubled to 49 percent between 1996 and 2001 while "reduced till" acres increased by one-fourth, accounting for another 33 percent of soybean acres. It estimated that these practices saved 247 million tons of topsoil in 2000, and reduced the number of times a farmer had to run equipment over the field, saving 234 million gallons of fuel. Conservation tillage, over the long term, also increases the number and diversity surface and subsurface arthropods including many beneficial predatory species. For instance, after the density of carabid beetles was	

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						50 times greater in no till soils than in conventionally treated soils, while the density of earthworms was more than 3.5 times greater. These worms not only serve as a good food source for birds, some of them— nightcrawlers, in particular — create vertical burrows which improves the ability of water to percolate into the ground and reduces the potential flooding [Refs: [1] American Soybean Association, ASA Study Confirms Environmental Benefits of Biotech Soybeans, Novemebr 12, 2001, online at <http://www.soygrowers.com/newsroom/releases/2001%20releases/r111201.htm>, visited on November 22, 2002. [2] R. Fawcett and D. Towery, Conservation Tillage and Plant Biotechnology (West Lafayette, IN: Conservation Technolgy Information Center, 2002). (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-1051	A	50	31			Suggest to add the following:Higher sediment loads in river due to increas in flood rates on catchment areas like, that of the Nile, as took place in the past (Stanley et al. 2001) , will cause higher siltation rates of dams, in this case Lake Nasser. Increase in the sediment volume may not have been taken into consideration by the planners. (Arie S. ISSAR, Ben Gurion University of the Negev)	
3-1052	A	50	33			Section 3.4.9. Is this meant to be a summary? It is quite fragmented and in some cases seems in conflict with previous text (e.g. hydropower). Explain the purpose of Table 3.4? (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	
3-1053	A	50	36	50	37	Irrigation water demands will increase unless crops and cropping practices are modified. See previous comment. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Table 3.4 will be deleted and section 3.4.9 will be deleted, some contents moved into 3.5 Costs and other socio-economic aspects
3-1054	A	50	36			Isn't this statement in direct conflict with statements made on page 46??? (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	No, but sentence modified.
3-1055	A	50	41			The dangers posed by joint-extremes should also be higlighted for policy-makers, and that there has been relatively little work in this area to date. (Robert Wilby, Environment Agency of England and Wales)	*Try to cover*
3-1056	A	50	45	50	49	Paragraph refers to the threshold maximum value what is meant by a threshold maximum value? (Harvey Hill, Prairie Farm Rehabilitation Administration)	Removed.
3-1057	A	51	1	51	20	Tune with information on irrigation in paragraph 3.4.6 (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Done. Sections 3.4.6 and 3.4.9 will move to 3.5.
3-1058	A	51	1	51	7	The first sentence states that irrigation needs will increase. The next sentence states	Lines 1-20 be deleted.

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						irrigation indicates irrigation requirements will be reduced. Should there be a sentence indicating that ambiguity at the beginning. (Harvey Hill, Prairie Farm Rehabilitation Administration)	
3-1059	A	51	1	51	7	Such simple statements were given in the first and second AR. If we consider page 36, line 28 - 42 it was shown that the complexity is much higher than the simplified view point presented here. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Lines 1-20 be deleted.
3-1060	A	51	1	51	3	On the contrary, the risk of more serious droughts during the summer seems to increase. Summer will start one to two months earlier, which together with increased evapotranspiration and especially with increased lake evaporation will lead to a much higher accumulated total evaporation over the summer. Thus although soil moisture storages and groundwater storages are well filled during the winter, they may not last over the longer summer. This is especially true where maximum winter values of soil moisture and groundwater storages will not increase, as is the case in southern and western coastal areas with shallow soil layers. In such areas more severe droughts are to be expected. In Lapland the risk of drying is smaller due to lower evapotranspiration and lake evaporation and a winter which will still be comparatively low. Vehviläinen, B. & Huttunen, M. 1997. Climate change and Water Resources In Finland. Boreal Environment Research 2:3-18. ISSN 1239-6095: (Bertel Vehviläinen, Finnish Environment Institute)	Lines 1-20 be deleted.
3-1061	A	51	7	51	9	This sentence is used repeatedly throughout the text (Cody Knutson, University of Nebraska-Lincoln)	Lines 1-20 be deleted.
3-1062	A	51	7		8	Please provide a reference. (Martin Savard, Geological Survey of Canada)	Lines 1-20 be deleted.
3-1063	A	51	9			Stomatal resistence conundrum again! (Robert Wilby, Environment Agency of England and Wales)	Lines 1-20 be deleted.
3-1064	A	51	12	51	15	This is wrong, increased drying from increases in heating with GHGs still causes wilting. (Kevin Trenberth, National Center for Atmospheric Research)	Lines 1-20 be deleted.
3-1065	A	51	14			Ditto (Robert Wilby, Environment Agency of England and Wales)	Lines 1-20 be deleted.
3-1066	A	51	24	51	26	Fortunately groundwater recharge will increase according to page 38, line 29 - 31. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Lines 22-26 deleted.
3-1067	A	51	28	51	31	Please include more general analyses done on climate change and dams, e.g. by the	The report by Arnell and Hulme (2000) on the

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						World Commission on Dams, see http://www.dams.org/kbase/thematic/tr22.htm (Laurens Bouwer, Institute for Environmental Studies, Vrije Universiteit)	impact of climate change on dams does not provide any specific information on impacts on reservoirs (just general impacts on inflow and evaporation) as there have almost been no studies.
3-1068	A	51	28	51	31	These lines can be deleted as the statement on page 46, line 38 - 45 is much more differentiated. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Lines 28-31 deleted
3-1069	A	51	28	51	31	Venäläinen, A., Tammelin, B., Tuomenvirta, H., Jylhä, K., Koskela, J., Turunen, M., Vehviläinen B. Forsius, J. & Järvinen P. 2004. The influence of climate change on energy production and heating energy demand in Finland. Energy & Environment 14(7).: ' The annual runoff will increase 0-8 % depending on the location of the watershed and on the climate change scenario used. The runoff increase is largest in northern Finland (Table 2) and in winter (Table 3).According to the HadCM3 A2 and B2 projections, the average power produced by hydropower plants will increase by 7 % and 11 %, respectively.' (Bertel Vehviläinen, Finnish Environment Institute)	Lines 28-31 deleted This is consistent with what results from the Pan-European study of Lehner et al. 2005 that will be cited in section 3.5.
3-1070	A	51	30	51	30	"..risk of failure to violate…": something is not right here; do you mean "...risk of failure to meet..." ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Lines 28-31 deleted
3-1071	A	51	30	51	30	It was not clear to me what was meant by the risk of failure to violate the corresponding constrains of energy production in Northern Greece. (Harvey Hill, Prairie Farm Rehabilitation Administration)	Lines 28-31 deleted
3-1072	A	51	31			…During the summer heatwave of 2003 hydropower production was reduced in Norway, France, and Germany. Power cuts occurred in Italy, France and Germany-with knock-on losses across many other industrial sectors. Thermal and nuclear power plants were closed because of either a lack of water for colling systems, or restrictions on discharging heated waters. Reference: Euraqua (2004): Towards a European Drought Policy. EurAqua Network of European Freshwater Research Organizations. (http://www.euraqua.org) (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Lines 28-31 deleted Relates to current sensitivities not future impacts. Discussed in section 3.5.
3-1073	A	51	37	52	1	The table 3.4 shall be completed with the appropiate regional information. For instance, current droughts affecting Argentina and Brazil are the cause of faulty irrigation for grain / cereal crops. Moreover, precipitation events (extreme and	Table deleted.

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						persistent light / moderate rainfall) have flooded urban and rural areas. A total of 8 million ha. were inundated in 2001/2002 in the Pampas and, because of increasing precipitations, 6 millions ha. in the arid middle - latitude central Argentina, became new agricultural / cattle rise lands. The reiteration of this events shall be listed. The rapid glacier's retract in the Andean tropics is also an important hydrological fact. (Osvaldo Canziani, IPCC)	
3-1074	A	51	37			Table 3.4 is good, in concept, but not well executed. It seems a bit scattershot – reflecting the fact that there knowledge is patchy on the topic. I'm not sure whether or not one can do better, but it shouldn't be used if it's going to be full of empty cells and question marks. (Rob de Loë, University of Guelph)	Table deleted.
3-1075	A	51	37	52	1	concerning future vulnerability, please give the meaning of high, medium and low (Chunzhen Liu, Water Information Center,MWR)	Table deleted.
3-1076	A	51	37			Table 3.4 should be completed and structerized, otherwise it is confusing. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Table deleted.
3-1077	A	51	37			Table 3.4. Useless. The most important uncertainty is that of GCMs, and not emission scenarios. The table never refers to any GCM. No feel of uncertainty relating to the magnitude and rate of changes. Delete or major revisions (Christel Prudhomme, Centre for Ecology and Hydrology)	Table deleted.
3-1078	A	51	37			Table 3.4: The content of this table is extremely inconsistent. Why IPCC was not able to harmonize these studies or (at least) rank them according to the level of confidence? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Table deleted.
3-1079	A	51	38			Table 3.4 . Every effort should be made to complete and improve this table. It looks incomplete! (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Table deleted.
3-1080	A	51				Table 3.4: effective, though still incomplete, summary of impacts on sectors. This type of tabulation should be utilized as much as possible throughout the chapter. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Table deleted.
3-1081	A	52	0			Table: 7th square from top: In the Near East there will be a decrease in groundwater recharge (Issar and Zohar 2004) (Arie S. ISSAR, Ben Gurion University of the Negev)	Table deleted.
3-1082	A	52	0			Table: 6th square from top: All Mediterranean countries will suffer from decrease in recharge and not only the southern rim of the Mediterranean Sea (based on	Table deleted.

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						interpretation of time series of proxy data (Issar 2003). Near East should be omittes (Arie S. ISSAR, Ben Gurion University of the Negev)	
3-1083	A	52	0			Section 3.5: Costs and other socio-economic aspects of what? What about options for adaptation, to cut water use, to increase storage, etc? (Kevin Trenberth, National Center for Atmospheric Research)	In 3.6.
3-1084	A	52	3	52	3	What costs? Adaptation costs or damage costs? (Laurens Bouwer, Institute for Environmental Studies, Vrije Universiteit)	Distinction made.
3-1085	A	52	3	53	34	This part shall mention what is mentioned regarding the already reviewed page __ line__. Decision making shall become aware of the urgent need to initiate adaption efforts from the necesary Earth Watch Systems. (Osvaldo Canziani, IPCC)	Comment unclear.
3-1086	A	52	3			Section 3.5 needs a lot of work if it's to be kept. It seems quite unfinished (and also, as noted above) duplicates earlier material. Is it necessary? Can it be incorporated elsewhere? (Rob de Loë, University of Guelph)	Section 3.5 will incorporate 3.4.6 and 3.4.9 and include new material.
3-1087	A	52	3			Section 3.5. Details are given for two examples (although the box is not referred to, see comment no 7), but there is no clear point made here. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Box is referenced now, and lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1088	A	52	3			Section 3.5: OK (Christel Prudhomme, Centre for Ecology and Hydrology)	Box is referenced now, and lines 1-38 and Table 3.5 deleted as not scientifically based
3-1089	A	52	3	52	5	Silander J. 2004. Economic impact of drought in Finland during 2002-2003. XXIII Nordic Hydrological Conference, Tallinn, Estonia,8-12 August 2004, NHP report no.48. ISBN 9985-56-921- 0 Cost more thab 100 milions euros.Also to table 3.4 (Bertel Vehviläinen, Finnish Environment Institute)	*check*
3-1090	A	52				At present this section has very little on other socio-economic impacts of climate change. The authors may wish to chase up the debates presented in the following papers; De Oliver, M. (1999) Attitudes and inaction: A case study of the manifest demographics of urban water conservation. Environment and Behaviour. 31, (3), 371 – 394. Aguilera-Klink.F., Perez-Moriana. E., Sanchez-Garcia.J., (2000). The social construction of scarcity. The case of water in Tenerife (Canary Islands). Ecological Economics 34, 233 – 245. Strzepek, KM; Yates, DN, (1996) Economic and social adaptations to climate change impacts on water resources: A case study of Egypt. International Journal of Water Resources Development. Vol. 12, no. 2, pp. 229-244. Fisher, Dana R.; Hale, Brack W.; Hinke, Jefferson; Overdevest, Christine Ann,	*check*

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						(2002) Social and ecological responses to climate change: Towards an integrative understanding. International Journal of Environment and Pollution. Vol. 17, no. 4, pp. 323-336. (Paul Jeffrey, Cranfield University)	
3-1091	A	53	0			This ground has been covered already previously in the chapter (changes in frequency of extreme events and increasing costs). The text here adds a bit of detail, but also duplicates (Rob de Loë, University of Guelph)	Lines 1-38 and Table 3.5 deleted as not scientifically based
3-1092	A	53	0			There should be a parallel piece on deaths and death rates due to floods and droughts. See previous comments in this regard. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	*Try to find*
3-1093	A	53	1	53	3	So what does this mean? Is this climate change or not? Please cross-ref to Chapter 1, Section 1.3.8.4 on disaster losses. (Laurens Bouwer, Institute for Environmental Studies, Vrije Universiteit)	Lines 1-38 and Table 3.5 deleted as not scientifically based
3-1094	A	53	1	53	3	Information presented in MunichRe findings and the famous graph may be explained in many ways. The main message is that these increases are not only due the change in climate - some possible explanations are accumulation of wealth, more detailed information available now than in the past, population increase, etc. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Lines 1-38 and Table 3.5 deleted as not scientifically based. Interpretation of such cost data will be provided.
3-1095	A	53	1	53	3	The observed increase is largely due to increases in population, wealth, and insurance cover. (Richard S.J. Tol, Uni. Hamburg)	Lines 1-38 and Table 3.5 deleted as not scientifically based. Interpretation of such cost data will be provided
3-1096	A	53	5	53	9	what is the basis of the stated risk rate for climate change ? Is there a literature citation ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1097	A	53	5	53	5	Can you really say that "there have been a number of significant climate change related extreme events"? I would rather say that "there have been a number of extreme events in recent years", or "there have been a number of extreme weather related events in recent years." No reference is cited. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1098	A	53	5			What means "climate change-related" events? How are these events related to changes? Just by definition or according to our general expectations? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Lines 1-38 and Table 3.5 deleted as not scientifically based.

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3-1099	A	53	6	53	7	Can we compare changes on two completely different scales? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1100	A	53	8	53	9	Needs reference. What's the "pure risk"? (Richard S.J. Tol, Uni. Hamburg)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1101	A	53	9	53	9	"2-4%" Where does this number come from? Can you say that the rate is rising? Maybe it "has risen" at this rate in recent years, but do you know that it will continue to rise? (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1102	A	53	10	53	28	There are other examples available. I can easily provide figures for the Red River flooding in 1997 (USA and Canada) and WMO associate program on flood management provides a set of case studies on their web site (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1103	A	53	11	53	27	This text is only looking at the UK. What about the rest of the world? Regarding the heat-wave: impacts were much larger in France and Switzerland. What about developing countries? It is estimated that the annual investment required in water services, regardless of climate change, in developing countries amounts to approximately 75 billion US$, a figure that is estimated to approximately double by the year 2025. See Camdessus, M., Winpenny, J. (2003). Financing Water For All: Report of the World Panel on Financing Water Infrastructure, World Water Council, Marseille, France. (Laurens Bouwer, Institute for Environmental Studies, Vrije Universiteit)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1104	A	53	11	53	13	Needs references. Claims may have doubled for all sorts of reasons, including decadal climate variability. In the UK, subsidence has increased, but not subsidence claims as this has been excluded from many policies. (Richard S.J. Tol, Uni. Hamburg)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1105	A	53	11	53	27	And p. 53. L29-30, and Table 3.5: what is relevance of this? What is basis of Table 3.5? (Kevin Trenberth, National Center for Atmospheric Research)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1106	A	53	13	53	13	I would replace the word "significant" with "outstanding", or something similar. (See associated comment no 26 below.) (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1107	A	53	27			The UK Government's Office of Science and Technology (OST) Foresight study also reports that annual losses from river and coastal flooding in England and Wales could increase by between £1 billion to as much as £20 billion by the 2080s	Thank you.

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						depending on the socio-economic (emission) scenario. (Robert Wilby, Environment Agency of England and Wales)	
3-1108	A	53	29	53	30	This statement is too broad and too general. What will change, and how much? Please refer to findings from WG1. (Laurens Bouwer, Institute for Environmental Studies, Vrije Universiteit)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1109	A	53	29	53	30	This statement does not belong in this section (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1110	A	53	29	53	30	Where does this conclusion come from? (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1111	A	53	29	53	30	Is there a reference the assertion that the statement on lines 29-30 can be made with high confidence? (Harvey Hill, Prairie Farm Rehabilitation Administration)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1112	A	53	29	53	30	On what evidence is this high confidence based? (Richard S.J. Tol, Uni. Hamburg)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1113	A	53	30			It's not clear where this "high confidence" comes from, considering we are unsure about projectionsof precipitation, we don't have a good idea whetehr run off has increasedor will increase in the future, etc. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Lines 1-38 and Table 3.5 deleted as not scientifically based.
3-1114	A	53	37	53	37	These estimates come from a non peer-reviewed source and should be deleted. Historical analysis show that socio-economic factors have been more important than shifts in climate, which makes these claimed increases in losses weak if they are not peer-reviewed. Please replace by refereed projections or attribution of historical analyses, see Chapter 1, Section 1.3.8.4 on disaster losses, and Chapter 14, Section 14.3.6 on human settlements. (Laurens Bouwer, Institute for Environmental Studies, Vrije Universiteit)	Lines 1-38 and Table 3.5 deleted as not scientifically based. Yes, will refer.
3-1115	A	53	37	53	38	In Table 3.5, it is not clear what the meaning is of a "total" for a column where there is a missing item, especially when this is included with a "total" for which there are no missing entries. (Donald Burn, University of Waterloo)	Table 3.5 deleted as not scientifically based.
3-1116	A	53	37			Table 3.5: Some more references to/explanation of these estimates are needed (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Table 3.5 deleted as not scientifically based.
3-1117	A	53	37			Table 3.5: This table need explanations. What is a "extreme year" (e.g. with regard of coastal floods - a year of many tsunamis) ? What are the conclusions for the IPCC with regard to the increasing damages by accumulated values at flood sites?	Table 3.5 deleted as not scientifically based.

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						(Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	
3-1118	A	53	38			Table 3.5 It is not clear what the costs in this table are for? Is this related to the UK case study? Explanation required. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Table 3.5 deleted as not scientifically based.
3-1119	A	53	41			What is Box 3.1 for? It's not mentioned in the text. (Rob de Loë, University of Guelph)	Will add text citing Box 3.1
3-1120	A	53				Table 3.5 presents very interesting projections, because the effects of socio-economic changes have been excluded. Amplification on how these projections were obtained would be desirable. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-1121	A	54	0	55		The case study of Okanagan should result in conclusions with regard to the report which could be generalized. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	There are several aspects; one is related to effects of earlier snowmelt; a second is methodological—value of collaborative research process with active role for water resource professionals and user groups
3-1122	A	54	0			Box: this is not an assessment: are the models any good, or credible? Is this of any value? (Kevin Trenberth, National Center for Atmospheric Research)	Can add text on calibration and testing of models
3-1123	A	54	1			The choice of the case is interested. It should be explained why? Not an area that will experience much do to the climatic change. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Semi-arid region with snowmelt as important component—other watersheds may be facing similar scenarios (Section 3.4.6); also, example of methodology of participatory approach, linking biophysical and socioeconomic aspects; scenario results described as change in risk of water shortage
3-1124	A	54	2	54	6	Please provide references(s) (Mohammed Karim, Ibaraki University)	Will refer to additional documents
3-1125	A	54	19			Box 3.1, Figure 1 are the crop water demand units on the right hand axis of the two graphs as the units referred to in line 11 of page 54? (Harvey Hill, Prairie Farm Rehabilitation Administration)	The vertical line indicating 30.3 million m3 corresponds to the horizontal axis, annual flow (supply); crop water demand is indicated on the horizontal axis (left hand side)
3-1126	A	55	0	57		Section 3.6: This section sounds good in the goals but never achieves an assessment, and there are no recommendations. (Kevin Trenberth, National Center for Atmospheric Research)	Poin taken
3-1127	A	55	0			Box: what are units in Table 1 in Box 3.1	Add units to table caption; table format errors

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						(Kevin Trenberth, National Center for Atmospheric Research)	to be corrected (column alignment); left column is ratio of cost of option compared to lowest cost option per unit of water; right column is percentage of water saved or added to supply
3-1128	A	55	18	55	36	Box 3.1 Table 1 needs more explanation for a better understanding (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	See 3-1127; the table shows that there are many adaptation options, but no single option will be sufficient
3-1129	A	55	23			Data for small holders shifted to the left by one column. What is the meaning of the percentages given in the right hand column? (Robert Wilby, Environment Agency of England and Wales)	See 3-1127; 1128
3-1130	A	55	39	60	36	This text seems to have no sub-heading. Is it meant to be a preamble for sub-sections 3.6.1 to 3.6.5 ? (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	New sections
3-1131	A	55	39	67	43	Section 3.6 looks too short as compared with the length of other in this same chapter (only 211 lines, two boxes - 3.2 and 3.3, and two tables - 3.6 and 3.7) Some shortcomings:K46 1. reference is made to water mix; however, no reference is made on the use of salty water to irrigate certain crops (coordination with Chapter 4) 2. recent installation of seawater desalinization systems (Singapore), the water-catching from persistent fog banks in coastal regions, seawater potabilization using sun energy, etc, should be mentioned 3. extreme events exacerbation due to climate change should be identified as early as possible as important factors in IWM methodology 4. Glacier's retreat: information shall be considered in coordination with the regional chapters. Some of these chapters take care of their geophysical and socio-economic effects. 5. Care is necessary when quoting studies on water agencies and managers comments negating the need to consider climate change in their water management activities (page 61 lines 46 to 48). Following the IPCC reporting practice, the last portion of the sentence should read "significant adaptive response to climate change might be not necessary". Nevertheless, taking into account the previous comments, this sentence should be cancelled out. This cancellation is also supported by the sentences starting in page 66, lines 39 and subsequent ones.. 6. Regarding "Limits to adaptation", the very critical geopolitical situations arising from international river basins, makes it necessary to emphasise the value of the international scale. This fact should be reflected in table 3.7	Poin taken

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						7. There is not much information on what should be done in developing regions and countries. The above mentioned Early Risk Warning Systems's development, with the urgently needed observation / monitoring hydrometeorolocial networks, with real time data exchange, shall be referred to decision making levels. Note that no comments are made on Box 3.2 The final comment on this section 3.6 is that there are many blanks to be completed. (Osvaldo Canziani, IPCC)	
3-1132	A	55	39			Section 3.6 opens with "Some technology options and practices" and then moves to a section on "Flood defences". If you're going to start with the technological solutions then you should follow with an equally (if not more) well developed discussion of demand management, behavioural, etc. solutions to the problems considered in the technology section. As it's written, one is left with the feeling that there aren't any! Wolff and Gleick (2002) is a good source for a different perspective. (Rob de Loë, University of Guelph)	Point taken
3-1133	A	55	39			Section 3.6: OK (Christel Prudhomme, Centre for Ecology and Hydrology)	
3-1134	A	55	39			For an in depth discussion of adaptation options and practises in the US water sector see: Miller, K. and Yates, D. 2005. Climate change and water resources: a primer for municipal water providers. Awwa Research Foundation, Denver CO, 94pp. (Robert Wilby, Environment Agency of England and Wales)	Point taken
3-1135	A	56	0			Why is water supply in waters-scarce regions "expected" to be supplemented by wastewater reuse, desalination, etc? Who expects this, and on what grounds? In some respects, these are old fashioned ideas. For a different treatment, consult Wolff and Gleick (2002). (More importantly, I would prefer to see the chapter taking a balanced approach, e.g., a clear position that we should try demand management FIRST and that we should try the technological fix only after all other options have been exhausted.) Wolff, G. and P.H. Gleick. 2002. The soft path for water. In The World's Water: The Biennial Report on Freshwater Resources 2002-2003, Editor. P.H. Gleick, 1-32. Washington: Island Press. (Rob de Loë, University of Guelph)	
3-1136	A	56	0			Mixing water from different quality regions?? Does this involve large scale interbasin transfers? The citation to Sen et al (2003) helps make the example more	Point taken

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						specific to a particular situation, but the earlier bullet "Long distance water transfers" does seem to open the door to large scale interbasin diversions. Is that something the authors really want to promote? Interbasin transfers are contrary to an emerging consensus in the literature (and in government policies in many countries) regarding the appropriateness of certain solutions to water problems; large-scale interbasin transfers are not generally recognized as appropriate. (Rob de Loë, University of Guelph)	
3-1137	A	56	0			There should be a discussion of non-structural options, including development of property rights for water, transferrable water rights, water pricing. Other options include developing and using crops with low water demand, changing agronomic practices (e.g., greater use of precision agriculture), even desalinization (a "structural" option). {see Goklany (2000,2002, 2005b), and references therein]. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-1138	A	56	10			"…the complementarity issue between adaptation and mitigation in the water sector" has not been adequately addressed by the chapter so far. Water and energy efficiency are linked. Improved water quality standards imply greater energy consumption for treatment. Major infrastructure developments have large carbon foot-prints. All these issues (and more) should be covered. (Robert Wilby, Environment Agency of England and Wales)	
3-1139	A	56	18			Reword "Technological developments may considerable affect.." (Robert Wilby, Environment Agency of England and Wales)	
3-1140	A	56	22			The potential for wastewater reuse in Europe has recently been considered by; Hochstrat, R; Wintgens, T; Melin, T; Jeffrey, P, (2005) Wastewater reclamation and reuse in Europe: A model-based potential estimation. Water Science & Technology: Water Supply. Vol. 5, no.1. pp67-75 (Paul Jeffrey, Cranfield University)	
3-1141	A	56	22	56	24	The authors state that recycled water is lilely to be used for 'high value' purposes. I presume that they are using the term 'value' in an economic sense and the general point is therefore well made. However, there are additional drivers for, and influences on, the exploitation of recycled water (e.g. public perception and opportunities for cascading water quality) that will create contrary examples. Water reuse applications are expanding to include reuse for irrigation, enhancing environmental flows, in-house use, low grade industrial use etc. Local conditions is very much the determining factor in the attractiveness of a reuse scheme. (Paul Jeffrey, Cranfield University)	
3-1142	A	56	29	56	40	To the options of expanding water supply sources should be added:a. Increasing recharge by artificial means like small dams. b. Increasing rainfall by cloud	

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						seeding. (Arie S. ISSAR, Ben Gurion University of the Negev)	
3-1143	A	56	30			Omit "…water treatment…long-distance transport:" (Robert Wilby, Environment Agency of England and Wales)	Point taken
3-1144	A	56	31			What about changing vegetation (e.g. reversing deforestation)? (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-1145	A	56	47	56	50	How? Cost? (Kevin Trenberth, National Center for Atmospheric Research)	NC
3-1146	A	57	14	57	17	The author might want to elaborate on this sentence to clarify what he or she means. (Harvey Hill, Prairie Farm Rehabilitation Administration)	NC
3-1147	A	57	19		22	There is another almost passing reference to integrated water management at this point. This really is an enormously complicated topic and a huge challenge to accomplish successfully. If the concept is going to be invoked in the chapter (which is appropriate), then it should be handled properly (with the same care, depth and thoughfullness as is given to modelling and forecasting). (Rob de Loë, University of Guelph)	Point taken
3-1148	A	57	21			Where is the ecology mentioned? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	NC
3-1149	A	57	24		27	I accept the first part of the sentence (Adaptation to changing conditions has always been part of water management) but I challenge the second part (historically this has involved changing demands for water). On the contrary, water management has historically been dominated by supply-side approaches that ensure that we don't have to change our demands! It has never (until very recently) been assumed that the natural resource base is constant. Instead, we've always historically (and even today) tried to change the resource base (e.g., by capturing "wasted" water that flows to the sea in spring) to serve our needs. (On page 60, lines 6-7, there's a statement suggesting that the authors also recognize this point.) The same paragraph then introduces a new point about assuming past conditions in future. It's a fair point, but shouldn't be jumbled in with the previous one (which is quite a different issue) (Rob de Loë, University of Guelph)	
3-1150	A	57	24	57	32	I found this to be a very useful paragraph (Harvey Hill, Prairie Farm Rehabilitation Administration)	
3-1151	A	57	24	57	32	This is a core finding that should be put forward more prominently (Nick van de Giesen, Delft University of Technology)	OK

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
3-1152	A	57	29	57	32	The writers make an interesting point about the 'stationarity assumption'. However, I would suggest that one of the implications of it not holding is that we are unable to evaluate what is 'over or under - designed', or 'overly costly'. (Paul Jeffrey, Cranfield University)	
3-1153	A	57	29			The assumption of stationarity is clearly wrong. (Kevin Trenberth, National Center for Atmospheric Research)	OK
3-1154	A	57	34			Not sure what the point of the "Flood defence" section is. If you're trying to illustrate that non-structural solutions exist, then a much better sub-section (if you can only have one to illustrate non-structural and behavioural solutions) would be the one I outlined above. There's a clearer link to the topic of climate change and a better balance. (Rob de Loë, University of Guelph)	
3-1155	A	57	38	58	8	see: DKKV (2004), page 10, Fig. 2 - "The cycle of flood risk management". (Uwe Gruenewald, Brandenburg University of Technology Cottbus)	
3-1156	A	57	42			“living with floods” and dying. Isn’t the cost of floods unaffordable too? Witness New Orleans and Katrina. (Kevin Trenberth, National Center for Atmospheric Research)	Revised
3-1157	A	57	45	57	46	Can be added?… relocate millions of Dutch and Hungarians living in flood risk areas… (third of the territorry of the country and 2.4 million people live on protected floodplains in Hungary, the network flood defences is half as dense as in Holland over a three times larger region) (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Revised
3-1158	A	57	49	58	8	(FINADAPT working papers.Adapting to climate change: current knowledge, future needs Final Seminar, Finnish Environment Institute (SYKE): 14-15 December :Water course management: Lake and reservoir regulation has to adapt to the changed seasonal runoff. Central lakes of catchments as Saimaa, Päijänne and Näsijärvi have frequent winter floods due to wet and warm winters. Frequent winter floods call for free storage capacity in reservoirs at winter and less storage capacity for spring in southern Finland. In northern Finland storage capacity is still needed for snowmelt floods. For longer and dry summers reservoirs should be filled up in spring in southern Finland. Better operative use of regulated reservoirs, more accurate and frequent observations and forecasts and even reconstruction of dam outlets are needed. Roughly estimated more than half of the 220 regulation permissions need adjustment. Cost depends whether the ad-justment needs to be processed through public announcement or not. Experiences thus far have shown that with lighter public announcement process takes 3-5 years.	

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						Flood protection: According to newest climate scenarios daily maximum rainfall increases up to 45 % which together with yearly precipitation increase demands better flood protection at urban and rural areas. Prolonged heavy rainfall events over large areas in southern, central and western Finland at summer 2005 cause serious flooding. The frequency of frazil ice jams may increase at southern and central Finland. In ice-free large rivers with high discharge sudden cold spells cause rapid frazil ice formation and ice-jams as at Kokemäenjoki during winter 2004-2005. Central lakes Saimaa, Päijänne and Näsijärvi will be more frequently flooded at winter due to increased rainfall and snowmelt. Western low pressures with westerly storm winds and extremely low air pressure cause flooding at the coasts of Finnish Bay. For adaptation to these threats tens of kilometers of levees should be constructed for endangered areas. Relocation of people may be needed in some areas. The land use patterns should be modified on shore areas. Pumping devices should be reserved for the protected areas. Higher limits for lowest building levels should be taken in use. Movable flood protection structures should be collected in depots. Construction methods and structures should be developed in order to lessen the vulnerability of houses for flooding. Updating of the guidelines of storm water drainage system is needed. Temporary storages must be built in city ar-eas. Weather radar based warning system for urban rainfall flooding should be made. Rescue people need training and equipments to mitigate frazil floods. Research is needed to asses the changes of floods with recurrence time 20-250 years to enable proper adaptation measures in regulation, flood control and mitigation and to determine lowest building heights. (Bertel Vehviläinen, Finnish Environment Institute)	
3-1159	A	58	1	58	18	This is the place where more work should be invvested (see my general comments) to discuss flood protection design criteria, urban drainage design criteria, integrated flood management, etc….) (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Sorry, page limit is critical.
3-1160	A	58	2	58	5	Note, that frequently false or at least exagerated hopes are associated with land use control and enhanced water storage. Those may be very useful for redistributing flow in time but in most cases are out of their storage capacity when destructive floods are under formation. It could be also expressed. (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Sorry, page limit is critical.
3-1161	A	58	6	58	8	These points seem important and maybe should be made into bullets?	

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						(Kevin Trenberth, National Center for Atmospheric Research)	
3-1162	A	58	7	58	8	Fully agree as to the need for site-specific measures. One point that could perhaps be made here is that protection in one area may enhance risk further upstream of downstream, especially for ice-jam floods. Selection and design of protection measures should take this into account. (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-1163	A	58	10	58	16	This part is not so relevant with the heading 'Adaptation: practice, options and constraints'. The author can omit this paragraph when space is limited. (Mohammed Karim, Ibaraki University)	Changed
3-1164	A	58	15			Makes no sense as USD is not a ratio? (Kevin Trenberth, National Center for Atmospheric Research)	
3-1165	A	58	19			Box 3.2. This box is far too long. About half of it reads like a promotion for NCAP (Netherlands Climate Assisstance Program). (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Revised
3-1166	A	58	19	60	34	I found this section very useful (Harvey Hill, Prairie Farm Rehabilitation Administration)	Thank you. Other referees have different opinion
3-1167	A	58	20			What's Box 3.2 for? There's no mention of it in the text. What's the connection to the surrounding text? By the way, the Kabat and Van Schaik (2003) reference I mentioned above comes out of the Dialogue on Water and Climate (the subject of Box 3.2) – so the authors of Chapter 3 clearly are aware of that initiative. (Rob de Loë, University of Guelph)	Revised
3-1168	A	58	20			Box: 3.2: Text can be reduced (e.g. remove p.59 l.24 to p.60 l.15) (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Revised
3-1169	A	59	24	59	49	Although I could privately agree with the saying "If it ain't Dutch, it ain't much" this may be a bit too much Dutch advertising. (Nick van de Giesen, Delft University of Technology)	Revised
3-1170	A	60	15			As NAPA (Adaption Plans) are mentioned as an option the interesting point would be their content. Could you be more specific e.g. by a catalogue of possible measures? To make a just a plan to cope with changes is not the solution ! Specify the topic and the content of planning in greater detail ! (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Revised
3-1171	A	60	37			Section 3.6.1 (Integrated water management) is welcome, but problematic. First, the characterisation of integrated water management is out of step with much of the contemporary literature. Second, it's very weakly supported with appropriate literature. I noticed an enormous depth of literature in section 3.4 (modelling, etc.)	Chneged

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						but very thin and weak support here -- even though a comparably large and sophisticated body of literature exists for integrated water management as exists for modelling! (Rob de Loë, University of Guelph)	
3-1172	A	60	37			Section 3.6.1: This section can be reduced (especially upto p.61, l.33). Table 3.7 is very general and does not add much. There is hardly any recent literature used for this paragraph (Marcel de Wit, Ministry of Transport, Public Works and Watermanagement)	Changed
3-1173	A	60	37			Section 3.6.1. This section simply introduces IWRM (Integrated water resources management). What does this mean for climate change. To justify this section, more direct, detailed links to climate and less detailed description are needed. Perhaps much of the present description can be replaced with reference to a few key papers, or a much reduced description could be put in a box? (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Revised
3-1174	A	60	37			The debate on IWRM is fast moving at present and I would like to see a more balanced view presented here which recognizes some of the weaknesses and challenges of IWRM. See; Biswas, AK, (2004) Integrated Water Resources Management: A Reassessment: A Water Forum Contribution. Water International Vol. 29, no. 2, pp. 248-256 Rahaman, MM; Varis, O; Kajander, T (2004) EU Water Framework Directive vs. Integrated Water Resources Management: The Seven Mismatches. International Journal of Water Resources Development Vol. 20, no. 4, pp. 565-575. (Paul Jeffrey, Cranfield University)	Reference noted. Decision on its inclusion pending
3-1175	A	60	37	62	11	Economic instruments are useful to control the demand for water towards using it efficiently. So adaptation to water shortage should introduce this aspect as the desired water policy. In addition to the traditional tax and subsidy instruments, the following measures must contribute to mitigate the water shortage: first of all, tradable permit for water use has been widely known as very useful way to attain the efficient water use. Especially Chile has successfully used this kind of water market and showed a considerable benefits from it. Moreover, water pollution permit is also used to reduce the environmental impact from economy. The recent literatrue worthwhile referring involve Tao et al. (2000, EnvResEcon), Weber (2001, JEEM), Hung and Shaw (2005, JEEM). The authors seem to focus too much on other aspects of adaptation like technology. Another important measure is to reform price system for water. In less developed countries, the price is in general set too low, so the reform must be important to face the water shortage. Dinar and Saleth (2005, in the International Year Book of Environmental and Resource	

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						Economics) well survey this issue with a great deal of references. (Ayumi Onuma, Keio University)	
3-1176	A	60	37	64	34	For the specific case of groundwater resources, the notion of water-resource sustainable development is well circonscribed by the concept of "safe yield". This concept relates the amount of water that can be withdrawn from a well or from a regional aquifer without affecting the ecosystem, historical access to water, surface water bodies or quality of groundwater above established criteria. I suggest the authors refer to this concept in their discussion of the integrated water management strategies (which should include aquifer systems). There is no doubt that any water management approach should be based on a quatitative assessment of water available and on protection of vulnerable areas above aquifer. (Martin Savard, Geological Survey of Canada)	
3-1177	A	60	37	65	1	IWRM is very important and it seems to make sense to advocate inclusion of climate change in IWRM, it is hardly the place to define and elaborate upon IWRM over several pages where room is limited. (Nick van de Giesen, Delft University of Technology)	
3-1178	A	60	37			This whole section (3.6.1) should be less abstract. Greater reference to actual examples would help illustrate some of the concepts. (Robert Wilby, Environment Agency of England and Wales)	
3-1179	A	61	24			The 30 years old statement of White with reservoirs as the first major elements of integrated watershed is not more valid in general. What about water transfer, waste water treatment and re-use etc.? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	
3-1180	A	61	29			Table 3.4 does not have anything to do with this unified river Basin Administration (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	
3-1181	A	61	47	61	48	But this is surely wrong. (Kevin Trenberth, National Center for Atmospheric Research)	
3-1182	A	62	0			There is nothing on changes in extremes here, or dealing with outmoded and poorly based allocations. (Kevin Trenberth, National Center for Atmospheric Research)	
3-1183	A	62	2			What is the meaning of "protocols"? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	
3-1184	A	62	14			Table 3.6 can be cancelled (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	

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3-1185	A	62	15	62	15	missing reference (Spyros Beltaos, NATIONAL WATER RESEARCH INSTITUTE)	
3-1186	A	62	18	63	4	Conflicts among countries located common international river or lake basins are expected to be more serious, due to the impact of climate change. More than 200 rivers in the world go through plural nations. International confilicts are already actual, for example, along Euphrates or Ganges, for example. So the chapter should shed a light more on this aspect, since this might be an important cause of polictical concerns and result in wars. There are not many treaties that define clearly how to allocate water between upstream and downstream countries. Approaches from game theory can contribute to the solution of the conflicts. Important studies include Rogers (1993) and Becker and Easter (1999, Land Econ.). They show that cooperative game is useful to solve the conflicts. (Ayumi Onuma, Keio University)	
3-1187	A	62	18	62	27	All platitudes. (Kevin Trenberth, National Center for Atmospheric Research)	
3-1188	A	63	1	63	2	IWRM is not defined. Also, LDCs usually referrs to least developed countries, a specific group of 55 of the world's poorest nations. Using the abbreviation to refer to less developed countries, which I assume refers to all developing nations, will only cause confusion. (Lenny Bernstein, IPIECA)	
3-1189	A	63	4			Reference not in the list - Schultze. Table 3.7 should be done properly. Columns do nothav etitles.Left and right do not correspond to each other, etc…. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Table 3.7 deleted
3-1190	A	63	7	63	8	Table 3.7 needs column headings for DC and LDC (it is clear which is which, but this should be included). (Donald Burn, University of Waterloo)	Table 3.7 deleted
3-1191	A	63	7			Table 3.7 is problematic. For example, the characterisation of developed country as capable and developing as weakly capable in the table is extremely simplistic. I can demonstrate capacity shortfalls in rural parts of Canada that are equal to those in developing countries. In other words, the suggestion that the "developed" world is generally/uniformly capable in the way described (e.g., "Expertise developed to local levels") is -- based on my own extensive research and the literature -- simply untrue. Other parts of the table are equally simplistic and naive (e.g., the public is "Generally well informed" with a "good appreciation of planning" and stakeholders are highly politically empowered in developed countries. (Rob de Loë, University of Guelph)	Table 3.7 deleted

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3-1192	A	63	7			more developed (left column)… less develped (right column) countries (Martin Savard, Geological Survey of Canada)	Table 3.7 deleted
3-1193	A	63	7			Table 3.7: Add a head line to differentiate between developed and developing countries. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Table 3.7 deleted
3-1194	A	64	1	65	12	Very incomplete, not possible to review (Nick van de Giesen, Delft University of Technology)	Changed
3-1195	A	64	17	64	34	Box 3.3 either more details or to cancel (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Box 3.3. deleted
3-1196	A	64	17			Box 3.3 is not complete. There are case studies available that are much more detailed. (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	Box 3.3 deleted
3-1197	A	64	17			Box 3.3: Not useful. (Kevin Trenberth, National Center for Atmospheric Research)	O.k.
3-1198	A	64	32	64	33	What is the expected outcome at present? (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	
3-1199	A	64	37			Section 3.6.2. No text given here at all. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Changed
3-1200	A	64	39			I hope this subsection is based on more than one case example, as the current text implies. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
3-1201	A	64	42			Section 3.6.3. This is just a collection of notes, what is the point? (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	Changed
3-1202	A	64	42			It would seem remiss to have a section on adaptive capacity and not include the work of the 'Resilience Alliance' (unless they are referenced in other Chapters) - see; Folke, C; Carpenter, S; Elmqvist, T; Gunderson, L; Holling, C; Walker (2002) Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. Ambio Vol. 31, no. 5, pp. 437-440. (Paul Jeffrey, Cranfield University)	Reference noted. Decision on its inclusion pending
3-1203	A	64	42			Much more is needed on adaptive capacity. Perhaps the UK Government's Adaptation Policy Framework (APF) would provide a useful model? (Robert Wilby, Environment Agency of England and Wales)	
3-1204	A	65	6			What is the source for the idea that "In general terms, there are three broad controls	See Arnell reference

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						on adaptive capacity…"? There are lots more in the literature – so this is a dubious point. This subsection should either be developed properly or dropped entirely. My preference would be to develop it properly (even if that means cutting back a lot of the material in Section 3.4 and some other subsections noted above, which covers material that is covered thoroughly and more effectively in lots of other recent documents) (Rob de Loë, University of Guelph)	
3-1205	A	65	22			There's a lot more literature out there on the limits to adaptation than the section (3.6.4) discusses. This is another section that seems to have received only passing attention in favour of a careful and detailed treatment of the results of modelling exercises. (Rob de Loë, University of Guelph)	References??
3-1206	A	65	25	65	25	the phrase 'and measures to alter demands to meet hydrological conditions.' would be better put as 'and measures better match demand with existing or anticipated hydrological conditions. (Paul Jeffrey, Cranfield University)	Agreed: good comment
3-1207	A	65	42			Please clarify what is meant by "No studies have so far attempted to characterise or identify precisely such limits to adaptation…". My first reaction was incredulous, in that I interpreted the statement to mean that no studies have addressed factors that limit adaptive capacity; that clearly isn't true as you cite one of my own in the previous paragraph (Ivey, et al 2004) that does just that! However, I think that what the authors really meant was that for a particular region (e.g., a basin or watershed), no studies have attempt to define the maximum possible adaptation. That's an interesting (and probably fair) statement -- although it's also debatable because it assumes that adaptive capacity is fixed (something I don't believe is the case at all). (Rob de Loë, University of Guelph)	Text will be rephrased: we meant the latter.
3-1208	A	65	42	65	50	I would suggest inclusion of work by Gleick at the Pacific Research Institute (1. California Water 2030, http://www.pacinst.org/reports/california_water_2030/index.htm; 2. Water Supply and the Impacts of Climate Change, http://www.pacinst.org/topics/global_change/climate_change_impacts/; 3. Water and Climate Change Bibliography, http://www.pacinst.org/topics/global_change/water_bibliography/ ; 4. Gleick, P.H., 1989. Climate change, hydrology, and water resources. Reviews of Geophysics 27(3), 329-344; 5. Gleick, P.H., 1987. The development and testing of a water balance model for climate impact assessment: Modelling the Sacramento basin.	Thanks for the references

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						Water Resources Research 26, 1049-1061; 6. Gleick, P.H., 1986. Methods for evaluating the regional hydrological impacts of global climatic changes. Journal of Hydrology 88, 97-116.). (Slobodan Simonovic, University of Western Ontario - Institute for Catastrophic Loss Reduction)	
3-1209	A	65	42	65	49	Leave out (Nick van de Giesen, Delft University of Technology)	Why? Will do so for reasons of space only
3-1210	A	66	1	66	26	The examples of limits to adaptive response provided in these paragraphs are appropriate but need some additional discussion to draw out the lessons which we can learn. (Paul Jeffrey, Cranfield University)	OK
3-1211	A	66	14	66	26	Despite all of the referred difficulties political decisions have been made by the countries of the Rhine and Danube basins by elaborating and approving through the corresponding international basin organisations flood action programmes for the implementation of many of the quoted concepts. (ICPDR, 2004) ICPDR (International Commission for the Protection of the Danube River) 2004: Action Programme for Sustainable Flood Protection in the Danube River Basin, ICPDR, Vienna, Austria www.icpdr.org/danubis (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Thanks for the comment
3-1212	A	66	14			Are the authors really that familiar with the literature that they're comfortable writing that "The most comprehensive research into the feasibility of different adaptation options has been conducted in the Netherlands and the Rhine basin…". First, what does "comprehensive" mean? Second, I wonder whether or not the statement is true. For instance, some very thorough and systematic research has taken place over the past decade or more in the Great Lakes Basin; the Okanagan study to which Box 3.2 refers is another recent example of comprehensive work.... The point is equally valid (without being unnecessarily contentious) when expressed as "Comprehensive research into the feasibility....". (Rob de Loë, University of Guelph)	Thanks for the comment – we'll include the additional references and rephrase.
3-1213	A	66	14			Instead of "The most" you should use "One of the most". (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	OK
3-1214	A	66	16	66	18	Tol et al (2003) do not conclude this. Dikes are useless in the upper reaches of the Dutch Meuse because the water would simply seep under the dike. Dikes along the Rhine can of course be raised further, but at enormous expense because of the dense use of this area, and because the current dikes are old and of unknown	Thanks for the clarification

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						material; one would have to remove the current dikes to build reliable new ones. (Richard S.J. Tol, Uni. Hamburg)	
3-1215	A	66	18	66	18	The Rhine delta can (and will) be given extra protection by simply building higher dikes… (Nick van de Giesen, Delft University of Technology)	..up to a point
3-1216	A	66	21			The on-going implementation of polders in the German Low Rhine region is opposite to this statement. (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Is this written up?
3-1217	A	66	28	66	34	Whilst Diamond's (2005) contribution is widely read and quoted, there are much better discussions of the limits to social adaptivity in the face of resource constraints to be found in (inter alia); Erickson, J and Gowdy, J.(2000) Resource use, institutions and sustainability: A tale of two Pacific Island cultures. Land Economics. 76(3):345-354 Tainter J. The Collapse of Complex Societies. Cambridge University Press, London, 1988 (Paul Jeffrey, Cranfield University)	Thanks for the reference
3-1218	A	66	37	67	43	If there is one part that is key to the chapter then it is 3.6.5 because it is also highly relevant to policy makers and water managers. (Nick van de Giesen, Delft University of Technology)	Thanks!
3-1219	A	66	48	67	16	This is only one, very limited way of dealing with a certain type of uncertainty. (Nick van de Giesen, Delft University of Technology)	Agreed
3-1220	A	66	50			Maurer and Duffy not in ref list (Martin Savard, Geological Survey of Canada)	Thanks for this
3-1221	A	67	10			Maheelpa and Perera (2003) missing from refs (Robert Wilby, Environment Agency of England and Wales)	Thanks
3-1222	A	67	18		32	These are good examples. Here are two more from a North American setting: (1) Hersh, R. and K. Wernstedt. 2002. Gauging the vulnerability of local water systems to extreme events. Journal of Environmental Planning and Management, 45(3): 341-361. (2) Palmer, R.N. and M. Hahn. 2002. The Impacts of Climate Change on Portland's Water Supply: An Investigation of Potential Hydrologic and Management Impacts on the Bull Run System. Seattle, WA: Department of Civil and Environmental Engineering, University of Washington. (Rob de Loë, University of Guelph)	Thanks for the references
3-1223	A	67	19	67	20	Dam safety: Design precipitation (recurrence time 1000-10000 years) increases up to 40-60 % can cause problems for dams below small catchments (10-500 km2). Increase of monthly or seasonal precipitation together with winter snowmelt are	Thanks

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						reasons for design flood increase for dams below large catchments (over 10 000 km2). In catchments with large lake systems late summer, autumn or winter floods will be the design floods in the future. Adaptation measures can be changed reservoir regulation, increase of outflow and storage capacity. Improved observation and warning systems, more accurate forecasting and improved readiness for mitigation actions and repairs are also needed. (FINADAPT working papers.Adapting to climate change: current knowledge, future needs Final Seminar, Finnish Environment Institute (SYKE): 14-15 December; Veijalainen, N. and Vehviläinen, B. 2004. Climate change and design floods in Finland. XXIII Nordic Hydrological Conference, Tallinn, Estonia,8-12 August 2004, NHP report no.48. ISBN 9985-56-921- 0 (Bertel Vehviläinen, Finnish Environment Institute)	
3-1224	A	67	20			Here a specification of the percentage should be given. Why not 10 or 30 percent? Please explain this guideline with its scientific basis used to define it. (Andreas Schumann, Institute of Hydrology, Water Resources Management and Environmental Engineering)	Text will be clarified: the 20% is actually based on one study
3-1225	A	67	22			As result of a transboundary research project the state of Baden-Württemberg/Germany implimented a guideline in July 2005, in which a surplus of up to 15 % on the design flood values is laid down (Lit. Landesanstalt für Umweltschutz (Ed.): Festlegung des Bemessungshochwassers für Anlagen des technischen Hochwasserschutzes (Guideline for the evaluation of the design flood for flood protection measures). Karlsruhe/Germany (2005). (Prof. Dr. Gerd Morgenschweis, Ruhrverband (Ruhr River Association))	Thanks for the reference!
3-1226	A	67	36			Reference to Integrated Water Resources Management is unconvincing (Rob de Loë, University of Guelph)	OK – will revise
3-1227	A	67	42			Increasing landscape "porosity" and allowing rivers to temporarily flood is consistent with the emerging Defra policies of 'Making Space for Water' (Robert Wilby, Environment Agency of England and Wales)	Will add reference
3-1228	A	67	46			The authors certainly are right to point out that "sustainability" is a huge topic. However, Section 3.7 doesn't begin to tackle it well enough relative to the topic. The section appears to be an afterthought. Again, if it's going to remain in the chapter, then it should be done properly; much less has written about this topic (climate change and sustainable water management) than about modelling and impacts -- so I'd be quite happy to see Section 3.4 trimmed dramatically to make the room! (Rob de Loë, University of Guelph)	OK – will try to do so!
3-1229	A	67	46			Sections 3.7 and 3.8. Both these sections are basically undeveloped. They are key	Developed now

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						sections that will be read by many; they must be concrete, direct and concise. (L. Phil Graham, Swedish Meteorological and Hydrological Institute)	
3-1230	A	67	46			Section 3.7: OK (Christel Prudhomme, Centre for Ecology and Hydrology)	Thanks
3-1231	A	68	0			General comments on Subsection 3.8 Key uncertainties and research priorities: This is a very important section of Chapter 3, and, as stated at its outset, needs to be developed much further. At its present form, it points out uncertainties in the simulation of precipitation in present climate models. There is no mention of uncertainties in the simulation of net radiation, the primary source of energy, and the most important component of land surface energy balance. Net radiation, not the temperature, is the primary driver of ET (latent heat flux). Uncertainty in the computation of net radiation, renders profound uncertainty in the computation of ET, one of the most important components of long term water balance. There is no mention of uncertainties in the simulation of subgrid-scale hydrologic processes at regional and local scales due to uncertainties in the estimation of the heterogeneous hydrologic parameters within the area of a computational grid. There is no mention of the uncertainties in the modeling of the nonlinear feedbacks among the atmospheric boundary layer and land surface hydrology processes that affect profoundly the simulation results of land surface fluxes, and, hence, ultimately, the hydrologic water balances. Finally, there is no mention of the uncertainties in the multi-scale modeling of hydrologic processes from the global to regional, to local scales. (Levent Kavvas, University of California, Davis)	Much improved
3-1232	A	68	1	68	33	This is not very relevant. I hope that "placeholder" means this will be replaced by something that is more relevant to what is described on p 67, lines 48-50 (Nick van de Giesen, Delft University of Technology)	Yes
3-1233	A	68	28	68	29	Digging the accumulated silt / mud from existing lakes and reservoirs in the Pampas' flatlands was an adaptation option proposed in Argentina as far back as+K521882. Nowadays, the Goverment of the City of Buenos Aires has programmed digging reservoirs to protect the urban area from the extreme precipitation events flooding the lower city's boroughs. The plan is being enforced; hence, this is a flood - protection example. (Osvaldo Canziani, IPCC)	
3-1234	A	68	35	68	36	You could consider the report by SEI on the MDG's for this section: http://www.sei.se/SustMDG31Auglowres.pdf (Laurens Bouwer, Institute for Environmental Studies, Vrije Universiteit)	
3-1235	A	68	39	69	12	This is unfortunately still very incomplete. Here should come a loud but rational	

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						cry for better modeling of future climate where it comes to water. This is the place to put pressure on climate modelers, otherwise the fifth assessment will have the same set of enormous uncertainties when it comes to the hydrological cycle. (Nick van de Giesen, Delft University of Technology)	
3-1236	A	68	39			Other research priorities include: [1] Opportunities and challenges surrounding the uptake of probabilistic climate change information in water resource and flood risk management, and how this latest science will be translated into practical guidance on adaptation measures; [2] climate-hydrological-ecological interactions are poorly understood and further work is needed to assess the sustainability of programmes of measures (as envisaged by the WFD) under climate change, when good ecological status is used as the yardstick of success; [3] seasonal and (especially) decadal forecasting techniques (e.g., for long-range drought outlooks) have yet to be fully incorporated in operational systems, yet these measures could bridge the gap between traditional weather prediction and climate change scemarios. (Robert Wilby, Environment Agency of England and Wales)	Yes
3-1237	A	68	46	69	9	Reference on the need to improve data availability (geophysical, biological and socio-economic) is a must. (Osvaldo Canziani, IPCC)	
3-1238	A	68	46	68	50	Very good and important sentence. Must appear in executive summary, and also should be seen in the results throughout the chapter - This is not the case at present (Christel Prudhomme, Centre for Ecology and Hydrology)	
3-1239	A	69	11	69	11	I trust that the section on detection and attribution of changes will give appropriate emphasis to the very important aspect of attribution of change. I think there has been considerable work looking at identifying changes, but unambigously attributing these to climate change remains a challenge. (Donald Burn, University of Waterloo)	Yes
3-1240	A	70	1			Szolgay, J. - Hlavcová, K. - Lapin, M. - Danihlík, R.: Impact of climate change on mean monthly of runoff in Slovakia. Meteorological Journal, 6, 2003, 3, 9-21 (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Reference noted. Decision on its inclusion pending
3-1241	A	70	1			Possible new items: (ICPDR, 2004) ICPDR (International Commission for the Protection of the Danube River) 2004: Action Programme for Sustainable Flood Protection in the Danube River Basin, ICPDR, Vienna, Austria www.icpdr.org/danubis ; (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Reference noted. Decision on its inclusion pending
3-1242	A	70	1			Possible new items: (Danihlik et al., 2004) DANIHLÍK, R. - HLAVCOVÁ, K. -	Reference noted. Decision on its inclusion

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						KOHNOVÁ, S. - PARAJKA, J. - SZOLGAY, J.: Scenarios of the change in the mean annual and monthly runoff in the Hron Basin. J. Hydrol. Hydromech., 52, 2004, 4, 291-302; (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	pending
3-1243	A	70	1			Balint,G.; P. Bartha, B. Gauzer, L. Szlavik: 2006: FLOOD FORECASTING AND WARNING DURING EXTREME EVENTS IN THE TISZA RIVER BASIN. NATO ARW "Extreme Hydrological Events: New Concepts for Security", 11-15 July 2005, Novosibirsk, Russia,In: Series: Nato Science Series: IV: Earth and Environmental Sciences, Vol. 6# Vasiliev, O. F. , van Gelder, P.H.A.J.M..; (Eds.) 2006, in press (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Reference noted. Decision on its inclusion pending
3-1244	A	70	1			(Szilagyi, 2001) :Szilagyi, J., 2001. Modeled areal evaporation trends over the conterminous United States, Journal of Irrigation and Drainage Engineering, 127(4): 196-200. (Gábor BÁLINT, VITUKI Environmental Protection and Water Management Research Institute)	Reference noted. Decision on its inclusion pending
3-1245	A	70	14	70	14	The correct title of this reference is "Climate Change in Contrasting River Basins: Adaptation Strategies for Water, Food and Environment". (Laurens Bouwer, Institute for Environmental Studies, Vrije Universiteit)	Reference noted. Decision on its inclusion pending
3-1246	A	72	14	72	16	Comment "The reference should be Bouraoui.. Impact of climatic …in a Finnish catchment. Climatic Change... (Pirkko Kortelainen, Finnish Environment Institute)	Reference noted. Decision on its inclusion pending
3-1247	A	76	2			Reference should be: Fowler, H.J., Kilsby, C.G., and O'Connell, P.E. 2003. Modeling the impacts of climatic change and variability on the reliability, resilience and vulnerability of a water resource system. Water Resources Research, 39(8), 1222, doi:10.1029/2002WR001778. (Hayley Fowler, Newcastle University)	Reference noted. Decision on its inclusion pending
3-1248	A	85	40			Please, include the following reference: "Rimbu N., C. Boroneant, C. Buta, M. Dima (2002): Decadal variability of the Danube river streamflow in the lower basin and its relation with the North Atlantic Oscillation. International Journal of Climatology, 22, 1169-1179." (Constanta-Emilia Boroneant, National Meteorological Administration)	Reference noted. Decision on its inclusion pending
3-1249	A	91	10			Zhou and Tol (2005) out of place and duplicated. (Robert Wilby, Environment Agency of England and Wales)	Reference noted. Decision on its inclusion pending