INTEGRATED DIALOGUE UNDER LONG-TERM PERSPECTIVES AS THE BASIS FOR ADAPTIVE WATER MANAGEMENT : A PROTOCOL OF EXTENDED SUSTAINABILITY

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Abstract. The inherent uncertainty of the futures requires an adaptive water management (AWM) which can best be achieved by an integrated dialogue (ID) among water scientists, policy makers and stakeholders. To develop proposals of extended sustainability the regional climate vulnerability is to be approached through gradually-evaluated models. This paper proposes a protocol that supports AWM and ID, including uncertainty analysis, scaling aspects and different types of dialogues that result in integrated scenarios, sustainability goals and finally policy decisions. First experiences of ID, supporting an opportunity to adapt this protocol of AWM in a bilateral project under regional climate vulnerability, are briefly presented. This paper is prepared to be discussed in the 11st Stockholm Water Symp., August 13-16, 2001: "Water Security for the 21st Century - Building Bridges through Dialogue", and "IV Inter-American Dialogue on Water Management : in Quest of Solutions", Foz de Iguacu, Brazil, Sept. 2-6, 2001.

Keywords: integrated dialogue, long-term perspectives, adaptive water management, protocol of extended sustainability, regional climate vulnerability.

1. Introduction

Global monetary values of freshwater functions account ca. US$ 8,000 billion a year and the impact of climate change costs the world US$300 billion a year [IUCN 2000; UNEP 2001]. Under current long-term perspectives of world water, slow improvements in water use efficiency do not keep us with increasing water demands to guarantee water security in the 21st Century. Under a "business-as-usual" scenario, slow improvements in water use efficiency will not prevent a further increase of water demands in the next decades, and even larger areas of the globe than today will suffer from water stress. By 2025, areas under "severe water stress" in the world will have expanded, and the number of people living in such areas will have doubled to 4 billion [Alcamo et al. 2000]. This future situation justifies strategies for quantifying global environmental security through integrated modeling [i.e. see GLASS Model, Alcamo et al 2001]. Only if there are major technological and institutional improvements as well as significant changes of societal values, water security can be achieved in the 21st century. In order to place water central in the sustainability debate, and to promote the integration of water professionals and stakeholders in strategic decision making, new approaches must be tried [IUCN 2000]. The following methods have already been proposed: 1) scenario development as a tool for integrated analysis and regional planning [e.g. Döll et al 2000], and 2) collaborative decision-making techniques among disciplines, stakeholders and policy makers to evaluate scenarios [e.g. Bender and Simonovic 1995].

In the context of sustainability-oriented regional planning, which intends to achieve environmental integrity, economic efficiency and equity, integrated scenarios of the long-term future can support present-day decision making. Scenarios are plausible images of the future; they neither predict the future, nor can they be qualified by their probability. On the background of alternative futures, the possible impacts of management measures and policy decisions can be assessed [Döll et al 2000]. However, there is not yet a lot of experience with developing water-related scenarios. In particular, it is not clear how to present the complex hydrological processes and phenomena, which are uncertain and scale-dependent, to stake holders and policy makers, i.e. persons not trained in hydrology. We must find ways to build bridges and to enable a fruitful dialogue that integrates across disciplines, sectors and interests as well as over all important water-related issues. Such a (continued) dialogue can then lead to an adaptive water management (AWM), in which flexible measures are preferred and former decisions are revisited and reassessed as time goes by (e.g. every five years).

According to own previous experience [Mendiondo 2001], the objective of this paper is to briefly propose an AWM through dialogue among groups of "water people" (e.g. river basin committees), working together under the perspective of sustainability (section 2). For that, we propose a protocol of integrated dialogue (ID) under long term perspectives as the basis for AWM. Some of our very first experiences of ID in a project in Northeastern Brazil are outlined (section 3). Further perspectives of the methodology are discussed (in section 4) such that scenarios could be flexibly adapted in building bridges to dialogue encouraged by the 11th Stockholm Water Symposium [SIWI 2000] and by IV Interamerican Dialogue for Water Management [IWRN 2001]. Initiatives of dialogue with perspectives are commented in the outlook (section 5).

2. A protocol of extended sustainability

Water professionals, like other geoscientists, rarely know enough about a problem to solve it definitively because of the complexity of the Hydrological Cycle, which leads to a high degree of uncertainty. The term uncertainty “should be used to describe situations without sureness, whether or not described by a probability distribution” [NRC 2000; p. 41]. There are two kinds of uncertainty: natural variability and knowledge uncertainty, thereby introducing the needs of analysis. *Uncertainty analysis* is the computation of the total uncertainty induced in the output by quantified uncertainty in the inputs and models, and the attributes of the relative importance of the input uncertainties in term of their contributions [Morgan and Henrion 1995, p.39]. Uncertainty of the Hydrological Cycle is often related to scale-dependence, i.e. there are aspects of complex systems that change with scale. In this way, *scaling* is the transfer of information between different spatio-temporal lengths [Sposito 1998].

Uncertainty and scale-dependence render the communication with policy makers and stakeholders difficult. The appropriate attitude to deal with uncertainty is to not seek definitive solutions, but to take small and flexible steps that can be modified and improved as our understanding is refined along time and across sectors. Besides, the concept of robustness should be used as a criterion for decision making; a robust decision being one that is likely to be fairly good under a wide range of possible futures [Holling 1978; Bender & Simonovic 1995; Van Asselt 1999]. Given the uncertainties associated with global change, an efficient water resources program is characterized by a flexibility that reduces the probability of a bad outcome and that involves delaying costly decisions that are hardly reversible as long as possible [Frederick et al. 1997]. Attitudes in favor of flexibility and robustness cannot be expected to prevail among policy makers (or water scientists), but must be encouraged by dialogue. Besides, uncertainty (and scaling problems) should be included in the dialogue among water scientists, policy makers and stakeholders.

We propose that *adaptive water management* (AWM) and the pertaining *integrated dialogue* (ID), could be supported by a protocol — basic rules of procedures describing the sequence of linked steps — that describe the practical work plan under long-term perspectives and uncertainty analysis. This protocol proposed by Mendiondo [2001] is presented in Figure 1. It provides the framework for collaboration between water professionals (scientists and policy makers) and stakeholders, with the goal of achieving an AWM, i.e. policies that can be adapted to the developing situation with the help of basic rules. In the *integrated dialogue* (ID), the attitudes of the participants are clarified, discussed and — as far as possible — harmonized, based on information as provided, for example, with the help of scenarios.

The dialogue is integrated in the sense that it is (1) *interdisciplinary*, with a better communication among water-related science, (2) *inter-sectoral*, to build bridges among stakeholders, and (3) *inter-generational*, in order to recognize lessons to be learned from the past and to take into account the maybe changing sustainability goals. A scheme of a protocol in support of adaptive management is shown in Figure 1 [Mendiondo 2001].

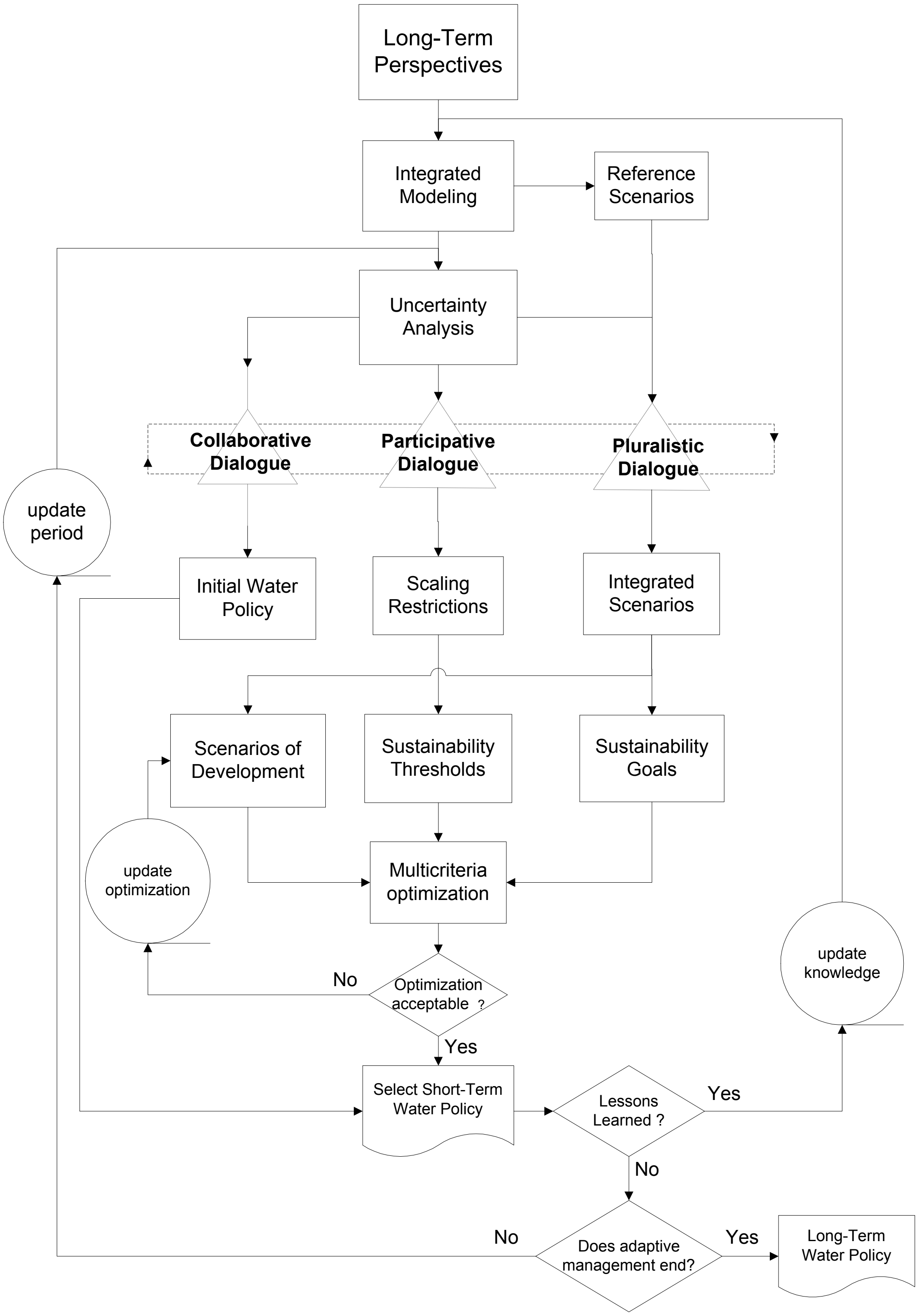

Fig. 1. Protocol of extended sustainability from integrated dialogue under long-term perspectives as the basis of adaptive water management [Mendiondo 2001]. See explanation on text.

Integrated modeling is the basis for AWM, where uncertainty analysis plays an important role as a *dialogue-generator*. It is the input to different types of dialogues which result in integrated scenarios, sustainability goals and policy decisions. Each type of dialogue has different rules (see below). To attain sustainability, AWM shown in Figure 1 is recursive, including short-term optimization loops, where scenarios are generated and evaluated by multi-criteria analysis. These scenarios maybe then regenerated on the lessons learned from short-term water policies. The later permits to re-visit decisions through medium-term loops and their outcome, to re-define sustainability goals and generate new scenarios in the long-term.

Some features could be rapidly outlined. First, it is worth noting that the protocol of Figure 1 is *not* a protocol for modeling, but for adaptive management, that is, the uncertainty analysis is treated at the beginning of a process of goal-evaluation under long-term perspectives. Second, uncertainty is considered as an input of further useful steps of adaptive management. For example, evidences of uncertainty (i.e. uncertainty bounds from a such uncertainty analysis) could be treated as inputs to *reservoirs of dialogue*, i.e. as dialogue skills and attitudes between water-interested people that adapt uncertainty evidence in order to address further steps of decision-making and policy criteria. Those reservoirs of dialogue could be implemented in workshops. Third, each of these reservoirs of dialogue has different rules according to the output desired. For example, in terms of adapt uncertainty evidences, a *pluralistic dialogue* adapts the uncertainty evidences to multiple perspectives of uncertainty treatment, i.e. helping to adapt integrated scenarios to sustainability goals from specific regions of economic, social and environmental characteristics. In addition, a *participatory* *dialogue* includes the different visions of the general public related to uncertainty. Further, a *collaborative dialogue* inter-plays abilities of the water-interested sectors to resolve communication issues efficiently and creatively and, further, to help in depicting the universe of initial decision criteria possible under long-term perspectives. In short, those basic rules encompass the *adapted knowledge* about the sustainability of a system under continuous change, coping with uncertainties through a "win-to-win" process and as tool of aiding integrated scenarios.

3. A Case Study of Regional Climate Vulnerability

The fore-mentioned rules of protocol (Fig. 1) need of case studies which have integrated modeling and opportunities of integral dialogues, i.e. with workshops. In this way, the proposed protocol is viewed as a tool looking forward to helping real steps within the framework of the German-Brazilian WAVES program: Water Availability, Vulnerability of Ecosystems and Society in the Northeast of Brazil (http://www.usf.uni-kassel.de/waves/english/index.htm). WAVES is sponsored by the German Ministry of Education and Research (BMBF) and the Conselho National de Desenvolvimento Científico Tecnológico (CNPq). The actual main project phase was started in 1997 and will be finished in 2000. The goal of WAVES is to identify sustainable development paths for two federal states in the semi-arid Northeast of Brazil which suffer from water scarcity (Fig. 2, area: 440 000 km^2, population: 9 million). WAVES focuses on the interrelation between regional climate variability, water availability, agriculture and the quality of life; an integrated model of the area, which includes sub-modules relevant for the above system components, was developed.

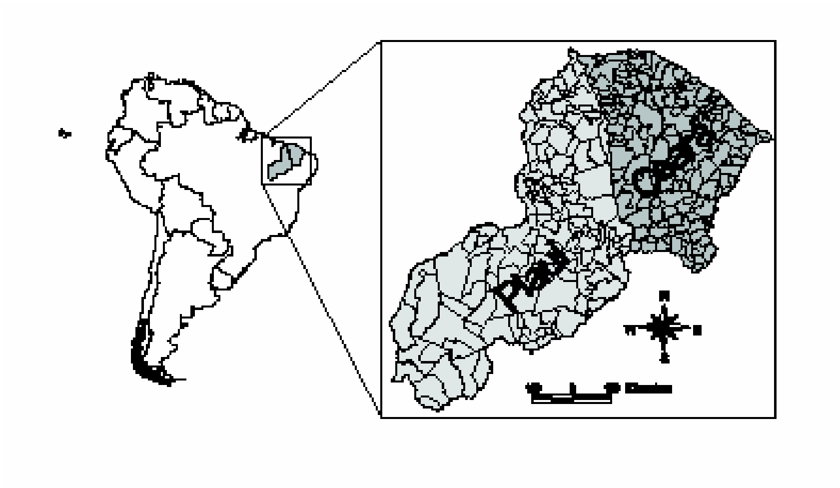

Fig. 2. The WAVES project area (see http://www.usf.uni-kassel.de/waves/english/index.htm).

As a first step, two reference scenarios were developed for the time up to 2025, which represent two different possible development paths of the states of Piauí and Ceará, which are divided into eight scenario regions. The reference scenario “Coastal boom and cash crops” describes what could happen in the region in a globalized world, while the reference scenario “Decentralization” shows a development that focuses on local resources. In the next step, intervention scenarios illustrate the impact of policy decisions. Finally, scenarios need to be evaluated. The methodology to derive qualitative-quantitative scenarios that are relevant for regional planning, with examples from WAVES, is summarized in Döll et al [2000].

Scenario generation and in particular the evaluation of scenarios should not be performed by scientists only, but in cooperation with policy makers and stakeholders. Therefore, a series of three workshops takes place in the years 2000 and 2001 which provide an opportunity for IDs. In these workshops, the reference scenarios proposed by the scientists are discussed and adapted according to the discussions with policy makers and stakeholders, intervention scenarios are defined and, finally, the scenarios are evaluated.

The results of IDs of WAVES workshops are documented (see http://www.usf.uni-kassel.de/waves/index.htm, and enclosed in Annex 1). In summary, the first workshop (November 2000) included an exchange of information on ongoing and planned policies. Discussions on the proposed reference scenarios were organized in parallel working groups. A first session of these groups focused on identifying the most relevant policy options for reducing vulnerability to drought, both long-term perspectives and specific drought measures. A prioritization of these policy options was made, and served as starting point for a second session of these working groups, considering the reference scenarios prepared by the WAVES program. The scenarios were evaluated, and their specifications, in particular the driving forces, were refined in particular with respect to policies that should either represented in the reference versions of the scenarios or be included in intervention variants. In the two follow-up workshops (mid March and late June 2001), the ID is extended to include more diverse policy makers and stakeholders, as in particular the evaluation of the scenarios requires a broad representation of society (presented in"International Conference of Global Climate Change & Regional Impacts: Achievements of the German-Brazilian cooperative research on sustainable land and water management in Northeastern Brazil" , http://www.usf.uni-kassel.de/waves/ , and summarized in Krol et al (2001).

4. Discussion

Could the protocol of Figure 1 be viewed as a device of "looking-ahead" of integrated modeling for scenario development and sustainability goals in regional planning ?. The adaptive management with integral dialogue proposed of Figure 1 may address the following questions:

(1) how can short-term decisions be adapted under long-term water perspectives ?,

(2) how could decision making and policy be adapted under uncertainty analysis, namely promoting "reservoirs of integral dialogue" ?,

(3) how should short-term actions take advantage of adapted knowledge through integral dialogue to address corrections and refinements of initial scenarios of development ?,

(4) how to adapt uncertainty, and i.e. scaling restrictions, into decision-making process ?,

(5) what kind of attitudes, in terms of flexibility and robustness, could be applied to re-visit previous conditions through adapted knowledge ?.

Due to the interdisciplinary approach of WAVES Program, the evaluation of the detailed results obtained from single disciplines is possible. The development of overlapping system interrelations is regarded as being as essential as deepen. The development of partial models and the inclusion of their results from the different disciplines into the integration field serves, first of all, to gain knowledge about the interrelations among stakeholders. Also, the joint solution strategies through dialogue collaborate with regional planners to update past decisions on ecological resources, the economy and the society. In short, they provide resilient policies.

To address driving forces and incentives for more-involved water professionals, our experience motivate the adaptation of the protocol to case studies in several ways. First, the isolation of water professionals from the key actors that set the agenda for development partially seems to be because of background constraints of the Planet Hydrologic Cycle, i.e. uncertainty, scaling of water processes, etc. According to integrated modeling, the recommendation is to re-visit those items into a framework of AWM with ID in order to gain ground in scientific issues without misleading practical outcomes that society usually waits from professionals.

Second, it appears to be a cumbersome critical point of addressing multi-objective optimization of scenarios that shift continuously, in space and time. The inclusion of sustainability thresholds (see Fig. 1) introduces an opportunity of research and dialogue between professionals and policy makers. The more integrated the scenario assessment, the higher priority of including system thresholds to link to sustainability scenarios.

Third, a common practice of professionals related to long-term reference and sustainability-oriented scenarios, with non-expected changes in medium term –by either policy decisions or new reference conditions – need of feed-backs and learning, visualized as loops in Figure 1.

Our experience permit to say that the fore-mentioned discussions could be implemented in following steps of integrated programs like WAVES, through adapting water management with integral dialogue under long-term perspectives.

5. Conclusion and outlook

The proposed protocol in support of AWM can help to address the following questions: 1) What are the best short-term decisions given long-term goals? 2) How can knowledge about uncertainty become helpful information for decision making 3) How can a continued decision making process be organized such that the changing knowledge and values is efficiently included? In WAVES, the first steps towards an ID, which is the basis for an AWM, have been taken. The interdisciplinary approach allows an integrated assessment which takes into account specific disciplinary results but focuses on interrelations of system components. Scenario generation was started by an interdisciplinary team of scientists and is now extended to include the participation of policy makers and stakeholders. There are quite a number of issues that need to be dealt with to make AWMs and IDs a reality. More work has to be performed on defining indicators of the systems state that allow to evaluate sustainability, or to identify a critical state of the system. Once these indicators are defined, thresholds for sustainability must be identified in a dialogue between scientists and society. The more integrated (and therefore complex) the scenario assessment is, the more important are transparent indicators and their threshold values.

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Annex 1.

Workshops of IDs of WAVES Project (prepared by Maarten Krol, with collaboration of Thomas Gaiser, Dagmar Fuhr Joachim Herfort, Mario Mendiondo, Claudia Abreu, José Carlos de Araújo, and Andreas Printz).

First Workshop of ID of WAVES, 28-29 November, 2000.

On 28 and 29 November 2000, a workshop was held at the Secretaria de Planejamento do Ceará (SEPLAN), Fortaleza, on the rational use of natural resources (especially water but also land) in this semi-arid region, with participation of SEPLAN, SRH, affiliated institutions and other secretaries, and from the WAVES project (see the list of participants).
Goal of the workshop was the exchange of information on ongoing and planned policies, reducing the vulnerability of the region on the one hand, and scientific instruments and findings on the other, aiming at a co-operation between SEPLAN/SRH and the WAVES project.
Presentations by Dr. Bergson Fernandes (SEPLAN), Dr. Gonzaga Ferreira (UFC), Dr. Thomas Gaiser (UniHoh), Mario Mendiondo (GHK), Dr. Maarten Krol (PIK), Dr. José Carlos Araújo (UFC), and Andreas Printz (TUM), provided a first exchange of information.
Lectures (in portuguese, PDF Format):

- Aplicação do 'Modelo Integrado do Semi-árido' (SIM), resultados exemplários e opções para aplicações
- Desenvolvimento de Cenários como uma Ferramenta para o Planejamento Regional
- 'Modelo para desenvolvimento sustentável do uso da terra' (MOSDEL) - aplicação ao município de Tauá

Discussions were mainly organised in 2 parallel working groups, led by Krol and Gaiser. A first session of these groups focussed on identifying the most relevant policy options for reducing vulnerability to drought, both long-term oriented policies and specific drought measures. A prioritisation of these policy options was made, and served as starting point for a second session of these working groups, considering the scenarios of regional development, prepared by the WAVES project. These scenarios were evaluated on plausibility and their contents were refined concerning specific policies that should either be represented in the reference versions of the scenarios or be included in intervention variants.

Results of the first session of the working groups
In the first session, contributions of the participants were gathered on the three topics (information requirement, long-term policy measures, drought management), and ordered according to their themes and to the possibilities of the WAVES program to support policy makers in each issue, e.g. by offering evaluations of possible measures by simulation.
Focus of the contributions was on water supply management, agro-economic policies, education and participation, and monitoring. Contributions on water demand management and agricultural technology also appeared, but somewhat less.
For most of the (technical) issues in water supply/demand management and agricultural economy and technology, WAVES can generate useful information for evaluating the effects of such measures. This generally requires a very concrete technical description of the specific measure.

Measures relating to education and participation have an obvious relevance in achieving a more sustainable usage of natural resources. Unfortunately, they can hardly be evaluated by WAVES; an amplification of activities in this field could be considered.
Improved monitoring could strongly support the understanding of the semi-arid environment and possibly allow for effective early-warning systems for drought. Such an operational task however can only be fulfilled by a state agency, with only a supporting role by research programs as WAVES.

Results of the working group on the "Decentralisation Scenario"
In the second session, one working group discussed the "Decentralisation Scenario" as developed by the WAVES program. The working group discussed the following questions:

- Is the scenario plausible in its present form, including an assessment of the plausibility of the present quantification of driving forces?
- What are the concrete regional policy measures that should be assumed to be implemented in the reference version of the scenario?
- What are possible additional policy measures that could be evaluated in intervention alternatives of the reference scenario?

The Decentralisation Scenario was generally felt to be plausible, and in many respects even along the lines of present planning of the state authorities.
The quantification of driving forces was generally accepted. Some doubts appeared, especially because in many of the tables in the distributed documents, changes were given predominantly in relative terms, making a sub-region to sub-region comparison in absolute terms hard.
Doubts on the scenario included:

- The negative trend in future potential agricultural area (also in the other reference scenario) seems inappropriate. The historic downward trend can solely be attributed to the recession in local cotton growing. Cotton popularity strongly increased from the late 1950s until 1970 but reduced to almost zero during the 1980s/1990s. This latter tendency clearly cannot be extrapolated linearly. A future trend will expectedly depend on assumptions concerning area used for other crops, which show an almost perfectly linear trend historically; plans for eventual future renewed cotton growing could be included.
- Developments in GDP were felt to be high for the region with low potential water resources and low for the coastal region, and should be checked.
- Urbanisation rates in the interior for scenario B are even higher than for the Globalisation Scenario. Absolute rural population numbers should be checked for consistency.
- Assessment of the assumptions on farm-size distribution of agricultural area was found to be hard, as some of the indicated lines in the figure on historic farm numbers got lost. Also, data on total farm area per size class were expected to be more illustrative.

The basis for the discussions on policy measures was formed by the results of the first day of the workshop. There, policy measures were discussed in a generalised sense on their relevance for reducing the vulnerability of the regional population for drought-related problems. Possible policy measures, both long-term oriented and emergency (drought) measures, were collected and organised thematically. For all policy measures appearing, the opportunities for the WAVES program to support the evaluation of the policy were assessed. A set of 6 themes of measures was defined, for which WAVES can provide a valuable policy support. Many other themes are thought to be of at least equal importance (as education, participation), but cannot be evaluated significantly by the WAVES program.

The 6 themes selected were:

1. Policies to increase water supply (additional dams, connections of catchments, transpositions, reuse),
2. Policies to reduce water use and improve sanitation (efficiency, spill loss reduction, clearance),
3. Technology improvements,
4. Changes in the agricultural sector,
5. Agro-economic incentives,
6. Concentration on regions with higher potentials.

From these 6, the first 4 were prioritised for discussion by the members of the working group. Concerning the policies increasing water supply it was discussed that:

- The construction of new dams should be part of scenario B. The list of 41 prioritised locations for new dams, available at COGERH, with an internal hierarchy of priority, and the concrete state planning for dam construction in the coming 15 years should be considered to define the reference scenario assumptions. Additional dams could appear in intervention variants. The finalisation of Castanhão should be assumed in the reference version.
- The transposition of water from the São Francisco should not be assumed in the reference scenario. At present, both Rio Grande do Norte and Pernambuco already decided against participation in the project, and Paraíba is still considering it critically, whereas Ceará is in favour, but unable to cover the non-federal costs alone. Transposition would be an interesting intervention variant.
- Small dams are assumed not to increase in numbers, reflecting policies reducing the negative impact of small dams on large reservoir functionality. Such policies are underway already.
- Connections between catchments in Ceará should be in the reference scenario. A network of these connections is meant to reduce impacts in situations where a drought occurs in some specific catchments but not in others, due to heterogeneity in precipitation. The network allows geographic redistribution of water, and is in planning.
- Reuse of water is an emerging additional water supply, see below.

Concerning water use reduction policy, sanitation, and technological improvements, discussions resulted that:

- Technological improvements in irrigation systems could reduce water requirements by up to 40%. If the costs of these improvements are translated into costs per m^3 of water demand reduction, they are even somewhat below the usual costs per m^3 of water supply increase by dam construction. A gradual improvement of water use efficiency should be assumed in the reference scenario.
- Water clearance, in combination with reuse, has positive effects on water quality and water supply. The opportunities to supply Pecém industry with reuse water from Fortaleza is under study and could be part of the reference scenario. Emerging industry in the interior (primarily textile and alimentation industries) could also partly be supplied with reuse water.
- Clearance of irrigation drainage water and eventual reuse could be studied in an intervention scenario. This could be an important policy in preventing reservoir eutrofication, but this cannot be described by WAVES at the moment.
- Water pricing for the irrigation sector was felt plausible after some 10 to 15 years only. Presently, the industrial and domestic sector do pay (partly) for their water consumption, and price developments in the scenario will influence future usage; no concrete expectations on price tendencies were formulated.

Structural reforms of the agricultural sector were felt to be of major importance to the decentralisation scenario. Time only allowed a short discussion, with following results:

- Plans of INCRA/IDACE on restructuring the agricultural sector could be used to define these parts of the scenarios. Which assumptions should be used in the reference versions and which in intervention variants remained open.
- Next to farm-size distributions, the distribution of access to credit over the farm sizes (and property characteristics) might be of dominant influence.

- ***Results of the working group on the "Globalisation and Cash-crop Scenario"***

The second working group discussed the "Globalisation and Cash-crop Scenario" (reference scenario A) as developed by the WAVES project. The following questions were discussed:

1. Is the scenario plausible in its present form, including an assessment of the plausibility of the present quantification of driving forces?
2. What are possible policy measures that could be evaluated in intervention alternatives of the reference scenario?

The Globalisation Scenario was generally felt to be plausible. Concerning the quantification of the driving forces, the population growth rate for Ceará was considered to be close to the most recent statistical evaluations of 1.34% per year. Some objections were made with regard to the quantification of the following parameters:

- Gross Domestic Product (GDP): Overall, the GDP rates are moderate expectations and acceptable, although there exist more optimistic predictions. The difference between the GDP of the metropolitan region of Fortaleza and other regions in Ceará has been considered to be too small.
- Population with low income: It is generally estimated, that when GDP increases by 10%, the proportion of the population with a low income decreases by 2.5%. This is not the case in the Globalisation and cash-crop Scenario. Probably, here the assumption of increasing social disparity is too rigid.
- Potential agricultural area: As in the first working group, the trend of future potential agricultural area in Ceará was considered to be inadequate. No concrete alternative assumption was proposed however.
- Irrigated area: The increase in irrigated area in the coastal region and the regions with low potential water resources was felt to be too high. (In regions with high potential water resources (Cariri) too low?) Figures should be checked together with the Secretaria de Agricultura Irrigada (Dr. Marcos). (Rule of the thumb: the irrigated area should be less then 5 % of the agriculture area).
- Farm size distribution: Assumptions seem to be reasonable. Only, in the coastal area the group of small farms is to low. Could be checked in co-operation with IDACE to be contacted through Márcia Maria Medeiros Dutra (SETAS). (Suggestion: comparable development with the south of Brazil today.)
- The following policy measures were selected to be included in the Globalisation Scenario, in decreasing order of importance:

1. Improved agricultural technology adapted to the semi-arid environment
2. Concentration of the population (in the rural areas) in regions with high potential resources
3. Policies to increase water supply (additional dams, connections of catchments)
4. Incentives of the government for cash crop production
5. Reorganisation of the land rights (distribution of land)
6. Governmental programs for reduction of the water demand
7. Subsidising small-scale non-agricultural business in the rural areas

Priority was given to measures number 1 and 3. Policy measure number 2 (Concentration of the population in regions with high potential resources) is an option, that is partly realised in

the other reference scenario (Decentralisation Scenario) and was not seen to be appropriate for the Globalisation Scenario.
Intervention 1: Application of improved agricultural technology adapted to the semi-arid environment
This policy was specified by an increase in the proportion of cashew plantations with improved cashew varieties, that show higher productivity according to the following rules (mean kernel production per year):

- actual (traditional) varieties (rain-fed production) 200 kg/ha
- improved varieties (rain-fed production) 800 kg/ha
- improved varieties (irrigated, intensive production) 4000 kg/ha

The absolute increase of cashew-growing area was not specified in the discussions, it was rather assumed that the actual cashew plantations are gradually substituted by plantations with improved varieties.
Intervention 3: Policies to increase water supply
Time was too short to fully discuss and specify this intervention. Participants pointed out, that there is a "Plano diretório" for the development of water infrastructure elaborated by SRH/COGERH. However, there was a general agreement, that medium-term policies will concentrate on dam construction and on connecting dams and watersheds within the state. The transposition of water from the Rio São Francisco is not likely to be realised within this decade.
In all discussions, the issue of education (e.g. when new technologies are introduced) was stressed again and over, and it could be worthwhile to elaborate scenario assumptions for this "driving force" of development.

Outlook on collaboration
SEPLAN/SRH and WAVES agreed to have two follow-up workshops, where the WAVES project will present results of scenario evaluations, reflecting corrections and refinements of the scenarios based on the discussions during the present workshop, as well as of intervention variants of the reference scenarios.
The follow-up workshops are planned for mid March 2001 and late June 2001.
Contacts points for the co-operation will be Dr. Bergson (SEPLAN) and Dr. Gaiser (UniHoh), who will be responsible for redirecting questions or data requests within the group of people involved at SEPLAN/SRH and WAVES respectively, for those cases where the direct bilateral contacts have not been established yet.

Second workshop of ID of WAVES, 13 - 14 March 2001.

This workshop was the second in a sequence of three workshops, aiming at the joint construction and analysis of reference scenarios of regional development and intervention variants, with emphasis on the (sustainable) use of natural resources (water and land) in the context of global change.
The first workshop in November 2000 focused on discussing and redefining the reference scenarios, where initial scenario ideas prepared by the WAVES project were a starting point. Results of this workshop served as input for the elaboration of the reference scenarios and the preparation of first intervention scenarios by the WAVES project for the present workshop. Focus was on re-evaluating adaptations of the reference scenarios and discussing interventions, to be analysed by the WAVES project for presentation and discussion at the third workshop in June 2001.

Representatives of the ministries of planning (SEPLAN), water resources (SRH), regional development (SDR), irrigated agriculture (SEAGRI) and of the hydro-meteorological service of Ceará (FUNCEME), Institute for agric. Development (IDACE), agricultural extension service (EMATERCE) and Institute for planning (IPLANCE) participated in the meeting, next to representatives from the German and Brazilian funding agencies (DLR, MCT and CNPq). Further, scientists from Brazilian and German research institutes involved in WAVES were present.

The workshop consisted in plenary presentations of project results on reference scenarios, intervention scenarios and methods at the state and municipal scale, and parallel working groups on water resources and land use. Some more detailed presentations of project results were given in the working groups.
The workshop was opened by Mr. Bergson Fernandes of SEPLAN. Dra. Mônica Clark, Minister of Planning of Ceará, presented the main policy directions and policy concerns of the Ceará government. Prof. Stahr and dr. Gaiser gave a general introduction to the issue of sustainability and the WAVES project. Next, on the first day of the workshop dr. Krol presented assumptions and results of the adapted reference scenarios (‘globalisation and cash crops’ and ‘decentralisation’), obtained with the integrated model SIM. Mr. Mendiondo, Dr. Krol, and Prof. Araújo presented assumptions and results on intervention scenarios (water pricing, analysed with the water use model NoWUM and alternative hierarchisation of extension of water supply infrastructure analysed using a new indicator for water stress). On the second day, Mr. Printz presented a geographical analysis of land and water resources for the municipality of Tauá using the model MOSDEL.
Closing statements were given by Dra. Mônica Clark, Dra. Katja Gilabert (MCT), Dr. Paul Bergweiler (DLR), Dra. Miranda Diogo (CNPq), and Prof. Karl Stahr.

The final WAVES-SEPLAN workshop is planned for 27 June 2001 in Fortaleza. There, results of this scenario simulations will be presented in the form of new and updated analyses according to the decisions of this second workshop.

Results of the working group "Water resources"

In the session on reference scenarios, Güntner presented results of the hydrological model WASA. Prof. Araújo presented an evaluation of water stress at the municipal level in Ceará for the period 2000-2025, suggesting an alternative hierarchisation of the construction of additional water supply infrastructure, based on the local lasting appearance of water stress (represented by an indicator), rather than on maximising an indicator of profitability. This approach was largely supported, as being complementary to the approach aiming at maximum returns in economic terms or in development potential.

Discussions on interventions, appearing both in reference and intervention scenarios, and on the appropriateness of indicators and other themes:

<u>Relate indicators to social data</u>: non-economic parameters should enter; relief of water stress and development of new water-using activities require a different treatment; subsistence and market production also; per-capita indicators are most appropriate in case of stress-relief

<u>Elements of an intervention scenario</u>: management of water demand and supply by wells and cisterns; water-use rights; water-quality and re-use

<u>Pricing in management</u>: relevant in long-term scenario; account for capacity to pay

<u>Evaluate uncertainty</u>: estimate temporal development in uncertainty; analyse confidence of results

Priority for drinking water supply: define maximum water use by irrigation per region; how are connections of catchments operated; analysis of drought in stress; stress at sectoral level

Qualitative aspects: water-borne diseases; public health in context of water resources; water quality decrease vs. demand increase; water treatment and its costs

Interference of small dam construction: effects on flow regulation and water quality

Adaptation to local conditions: education; water-user associations/committees

Interventions of environmental recovery: analyse possible recovery or damages by new infrastructure

The WAVES group will address some of these issues in their analyses to be presented at the next workshop in June 2001.

In discussions on intervention scenarios, it should be noted that no plausible reference scenarios could be assumed without a number of policy interventions in it. Intervention scenarios are meant to analyse the effectiveness of additional interventions; interventions already adopted in the reference scenario could be evaluated by omitting them in an alternative 'intervention' scenario.
Additional interventions are best studied in both reference scenarios, not only to assess their effectiveness but also its contextual robustness.

Proposals for and discussion issues on intervention scenarios were:

Integrated vision: combine demand- and supply-management; account for carrying capacity; multi-criteria analyses; support structural interventions with emergency policies.

Comparison of studies: WAVES reference scenarios vs. long-term management plans for catchments (baixo Jaguaribe, Metropolitana)

Inclusion of user profiles in water licence: principal use, socio-economic activity, impact on quality, social return should influence water use licences (e.g. drinking water stress next to large irrigation projects unacceptable).

Database support for licensing: physical characteristics (soil, geomorphology, runoff, aquifers)

Drought fund: make drought programs independent of actual political situation

Management of prices and costs for water use: public vs. private, bonus for efficiency, price differentiation (for use, user and source)

Re-installation of infrastructure: consider restarting use of non-active infrastructure

Small interventions and diffuse water demand: prioritise small structural interventions (wells in cristaline, desalinisation); define priorities in use of water-sources for diffuse demand;

Participative action: formation of catchment committees; involve communities in operational tasks; education

Improved efficiency in irrigation: compare irrigation centres for suited crops; identify optimal irrigation conditions; price incentives; re-use

Transposition: study impacts on water demand

Improved efficiency in domestic and industrial water use: what are limits to efficiency improvement; transmission losses in distribution

Qualitative aspects: analysis (mapping) of water-born diseases

On many of these topics, WAVES can support evaluation of the interventions; some issues will be addressed at the June workshop. For some other issues, the lack of available information is hampering a quick assessment; especially issues depending on the allocation of sectoral water use to water supply sources.

In the session on Tauá, Dr. Külls and Voerkelius presented water balance modelling for climatologically typical years (wet, dry, …) coupled with GIS, focussing on groundwater renewal. The approach enables the assessment of site-specific potentials of groundwater use; further calibration and validation is required to represent regionally typical effects of re-evaporation of groundwater renewal. This re-evaporation results from low conductivity of cristaline rock, blocking deeper aquifers, and leads to salinisation. Therefore, increased groundwater use through e.g. artificial recharge of subsurface storage would require additional drainage. Groundwater could be a serious alternative to surface water, especially as a strategic additional resource for dry years in a combined concept of surface- and groundwater use.

Results of the working group "Land use management"

The working group started discussing the updated assumptions of the reference sceanrios, which are relevant for land use. Concerning the 'potential agriculture area', it was stressed that external (market price) factors have great influence on the extension as well as on the preference of the crop mix. The new breed of woody cotton shrubs e.g. shows resistance against the cotton pest and could have good prospects to reach the historic extensions, but would need subsidies for introduction. Limitation for area is also given by the water resources. Many of these determining factors depend on the politics in the future and are hardly to estimate. An example intervention scenario would be the impact of 'Canal do trabalhador'. Nevertheless, the participants agreed in the proposed numbers of decreasing potential area for agriculture, which bases on the actual decrease rate. In general, there has to be remarked the transformation in the land use of the Northeast. Abandoning of land with marginal soils on the one hand and intensification of better land on the other hand. Especially in these areas the competition between the annual cash crops and animal husbandry will increase. The importance of fishery is expected to increase rapidly.

Concerning the 'potential irrigation area', it was agreed, that the assumption of scenario A (from 137 up to 336 ha) is not realistic. In the history of assumptions of the irrigation development, there always has been an overestimation on this point. Representatives of the irrigation secretary consider 170.000 ha (appearing in many studies; used also for scenario B) as the upper limit of potential irrigation area in Ceará. The IBGE statistics of irrigation areas are surely not representing reality as they are multiplying the same area by each yield. The general tendency of reduction of the farm size was agreed. Concerning the aggregation of small farm to medium ones, participants were not as sure.

Many participants do not use the IBGE statistics, as they reflect the actual (and very dynamic) land user, but not the owner of the land.

Dr. Gaiser presented SPICE as a soil based agriculture production information system and Mrs. Höynck gave an introduction to the RASMO model for optimization of the regional agricultural sector.

The working group discussed in more detail the potential intervention of promoting the cultivation of new cashew varieties ("Cajú Anão") in the state of Ceará.

Mr. Yoshio from IPLANCE made a brief report about the history of cashew cropping in Ceará. The extension of cashew plantations in Ceará in the past (since '80s) was mainly due to the fact, that the planting of cashew trees was subsidized through funds for reforestation. Some new highly productive cashew varieties appeared already by the end of the '70s, but the technology was somehow difficult to adopt and there were no funds for investments (costs of seedlings or seeds). Today, there is a tendency that the proportion of new, highly productive cashew varieties increases, even with small-scale farmers.

In order to specify the intervention scenario, some technical details about the management of the new varieties were discussed. The most common method to establish the new varieties is planting of seedlings followed by direct planting of seeds. Further specific technical details on the management of the new cashew varieties will be acquired by Sabine Höynck. According to the experts, the most serious obstacle to the expansion of cashew plantations is the low price for the farmer (0,35 US$/kg raw kernel) compared to the price on the world market (0,60-0,70 US$). Hence, the improvement of marketing (e.g. through the marketing of large amounts by farmer associations) is highly desirable. In addition, the utilization of the cashew fruit as basis for soft drinks or as animal food could encourage intensification of the cashew production. Presently, about 95% of the cashew fruits are just rotting in the plantations.

Finally, other possible scenarios for the state of Ceará in the area of agricultural production were discussed:

1. Extension of fruit production (honey melon, mango, coconut pulp) or flower production (in the mountainous regions) for exportation
2. Plantation of coconuts in connection with production of coconut milk in tetrapak for local market (and exportation?)
3. Extension of fruit production for the local market in Ceará (banana, papaya, pineapple, raisins, guava, graviola, acerola). Still a large proportion of the fruits consumed in Ceará are imported from other states.
4. Extension of pepper production (pimenta) for small-scale farmers in the coastal region for the local market.
5. Production of (coloured) cotton with new varieties, recently developed by EMBRAPA for small-scale farmers in the "Sertão" without access to irrigation facilities (compare also potential scenarios for the Tauá region in the minutes of the third meeting).

Alternative assumptions for scenario of decentralisation were discussed for the municipality of Tauá, where a stimulation of non-agrarian activities was proposed (industries related to handicraft, tourism, mining, small scale husbandry for meat and leather industry). Here, the carrying capacity of the region should be respected, educational programs were necessary, and the local population should have a decisive vote.
For the Trici valley, it was suggested to study the potentials for groundwater extraction in the margins of the riverbed, as is done in projects in Quixeramobim. Small scale irrigation of fruit, herbs and seeds could be optimised using these water resources.
The scenario of globalisation and cash crops was not discussed, as the region of Tauá is most likely to be abandoned in this scenario.

Then, it was discussed which output variables of the models are desirable, clustered in four groups: ecology, water resources, employment and economy. Variables identified were:
<u>Ecology</u>: agricultural suitability of the soil, areas suitable for irrigation, regionally optimal irrigation systems.
<u>Water resources</u>: groundwater potentials, planting dates for short-cycle crops.
<u>Employment</u>: number of employed per activity, development of employment and income, check of tendencies.
<u>Economy</u>: profitability of production systems, estimation of break-down of production, evolution of prices.
The complete list of desired output parameters is attached to this document.

Short Biography of the Authors

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