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Scenarios for Closed Basin Water Management in the Zayandeh Rud Catchment Area

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Notice

This report presents results regarding the scenario development in the Zayandeh Rud Basin in Iran. The activities are part of the main module in the German-Iranian Research Project "Integrated Water Resource Management (IWRM) in Isfahan", funded by the German Federal Ministry of Education and Research (BMBF). A preliminary draft version has been discussed with the Iranian Partners and agricultural stakeholders in February 2014.

The report, its contents and its validations are accounted solely by its authors, working in the ISOE – Institute for Social-Ecological Research GmbH.

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Content

1 Introduction

Zayandeh Rud river basin is one of the most important catchment areas in central Iran. The river is highly relevant for the socio-economic development of the province Isfahan and its neighbouring provinces, On the one hand, it provides drinking water for approximately 4.5 million residents of Central Iran. On the other hand, its water is the irrigation source for about 250,000 ha of agricultural land and provides water for the second largest industrial area in Iran (Felmeden 2014, Mohajeri et al. 2013, 2014).

The catchment area has been repeatedly challenged by water stress during the past 60 years. There had been a gradual change from good governed use of the river and corresponding qanat management to one where there was a break-down of the old irrigation schemes. During the last decades, the growing demand in the Zayandeh Rud basin has largely been met by inter basin water transfer and also by mining fossil groundwater resources. Despite all progress in water management and an improved control over the water resource the present state is very critical. There is not only an over-allocation of the water resources. Climate change might cause the next break-down of the (agricultural) production in the water basin, as the last years indicate with their heavy droughts and a resulting reduction in irrigation water supply (from surface water and critical states in groundwater).

Even for the lay-man, it is quite evident, that Zayandeh Rud is overused – not only water scarcity, but also poor water quality and environmental damages are the consequences. As the name of the river Zayandeh Rud in Persian implies that along its course of flow the river obtains new water from return flow of withdrawal uses occurring upstream or tributaries along the river basin. In recent years, share of groundwater in the total water used for irrigation has increased in many areas to compensate for the surface water shortages, resulting in serious groundwater depletion, threatening the long-term sustainable development especially for that part of the agricultural sector, using groundwater for irrigation.

At present in the Zayandeh Rud basin there is a complex interaction of the water flows of the different user groups, especially between water for agriculture and water for industrial supply, but also between residential (waste) water and irrigation water. There is also a complex spatial intertwinnedness of uses and flows between the river valleys and highlands (most tributaries to Zayandeh Rud have been fallen dry due to anthropogenic reasons). Due to the over-allocation the only way for creating leeway will be in common (or concerted) action of the sectors: In the future industrial or agricultural water needs will have to be covered by reallocations from urban water management. More interbasin transfer is the only alternative to those actions who are typical for an improved integrated water resource management.

The Zayandeh Rud basin is an extreme example of downstream vulnerability: East of Isfahan due to lacks in the water quality the range in cultivars is diminished. And since more than 15 years the water flow into the Gaw Khuni salt pan is at an historical minimum and endangering the ecological properties of the unique ecosystem protected by the UN’s Ramsar Convention.

The German-Iranian project “IWRM in Isfahan” is an attempt to improve the water management in the catchment area by developing alternatives in management. Based on sectoral studies (Felmeden 2014, Mohajeri et al. 2013, 2014, Sauer 2014, Schramm/Davoudi 2014) concept studies (p2m 2014), process evaluations (p2m 2013) and an economic report (IEEM 2013) our scenarios are integrating the knowledge of the project. With the help of the also developed Water Management Tool the results of the scenario process reported here may be illustrated and modified to gain further understanding of alternatives in action.

Purposes of the project's scenario development

Water scarcity problems are characterized by their complexity with regard to drivers and pressures such as climate (-change), soil characteristics, hydrogeology, vegetation dynamics as well as socio-economic, technical and administrative issues.

The fundamental purpose of a (sustainable) water resource planning and management is to match the demand for water by the allocation of water with attention of the important socioeconomic goals such as equity and security through administrative control and management tools such as water regulations/laws and infrastructure, without compromising ecosystem sustainability (Dong et al. 2013, Kirchhoff et al. 2012).

Scenarios are not predictions of the future but should help to understand the range of alternative futures and their possible consequences that we might have to face. Scenarios have been used as an important tool for strategic planning and policy making, which provide a framework that allows the search for possible solutions to persistent problems of unsustainability, taking into account various dimensions like the socio-economic, technical and environmental issues etc.

Moreover scenarios are able to demonstrate the policy makers some consequences of their decision makings and allow them to take in consideration the different driving forces of the processes and their interactions. In the case of the future water use/needs scenarios for the Zayandeh Rud River basin, the three scenarios show a different range of alternative futures especially when a limited amount of regional information was included to quantify the so called storylines (narrative descriptions) of the scenarios.

A key goal of the scenario developing in the main module of the German-Iranian joint project "IWRM in Isfahan" is to make aware the decision makers and water resources managers in Isfahan (but also their potential stakeholders) with possible consequences of their decisions and empower them to think of management alternatives (cf. Mohajeri/Nuñez von Voigt 2011).

Doing such a study from abroad is a difficult task. We would like to thank the Isfahan Regional Water Company's staff and especially Mr. Abbas Asady and his team for his kind and invaluable cooperation and support in gathering the informations, for answering our questions and for arranging the workshops; Mr. Aghili did a great job by translating most of exchange activities, contributions and discussions, but improved with some questions also our report whilst in progress. Special thanks go to Dr. Hamid R. Safavi (Isfahan University of Technology) , Dr. Alireza Nikouei (Isfahan Center for Research of Agricultural Science and Natural Resources), Mr. Sarafrazi (Jihad-Agricultural Organization MAJ) and especially Mr. Lotfollah Ziayi (ZayandAb Consultants) for invaluable hints and proposals and to Dr. Sharooz Mohajeri (inter3) for intercultural adjustment of the scenario process.

2 Procedure and approach

2.1 Scenario planning

Mankind has not the ability to predict the future (only in certain cases prognoses are possible, e.g. weather forecast). Therefore scenarios have been developed as planning and/or communication tools used to think the unthinkable and to explore uncertain and unknown futures.

Scenarios consider courses of action and their alternatives; therefore they are particularly suited to decision-making, especially under conditions of uncertainty and/or complexity. Scenarios have not to be misunderstood as predictions or as scientific extrapolations. In contrast to linear trend projections or forecasts, the aim of scenario planning is not the exact prediction of a development or its computional extrapolation but rather the description of a range of possibilities which encompasses several developments in the future. That is why the scenarios are defined as "structured accounts" or representations of possible futures; they "describe futures that could be rather than futures that will be." (Peterson et al. 2003) Methodologically a scenario is understood as a plausible description of how the future may unfold based on 'if-then' propositions (in some cases also 'what-if' propositions).

Appropriate methods of scenario building have been developed by Hermann Kahn and colleagues of the RAND organization after second world war. Scenario building approaches also allow to develop coherent, plausible internally consistent descriptions of not only one, but normally a bundle of alternative futures (Bishop et al. 2007, Steinmüller 1997).

Typically, scenarios on future developments include a number of futures being descripted in a narrative component. Very often those narrative kernels are vivid stories that are constructed in such a way that the decision makers may have imaginations of a range of future developments. Beside the images of the future the scenarios

also include potential (not in all situations feasible) pathways connecting the present with those narrative "storylines". But scenario planning is not an exclusively qualitative method. Sometimes a connection of the scenarios with quantitative aspects is possible.
The key elements of scenarios are:

- a base year and the given state of things in this year;
- a time horizon with the end point in time treated in the scenario and the state of things at that time;
- a geographical area – the spatial coverage of the scenario, e.g. the whole catchment area or a part of it, like a province or the area of an irrigation network;
- driving forces or uncertainties – the main factors that influence the scenarios and are causing their change;
- a storyline – a narrative that presents the important aspects of the scenario.

The scenario analysis process comprises the development of scenarios (with the points mentioned above), the comparison of the results of the different scenarios developed and also an attempt to evaluate their consequences (cf. Kerber et al. 2014, Steinmüller 1997).
In the natural and engineering sciences there is a different understanding of scenarios. There a scenario is regarded as a coherent, plausible and internally consistent description of a possible future state of the scenario world. Very often they include computer simulations extrapolating current trends or are even based on those modelling approaches so that the storylines are derived from certain simulations. Sometimes the scenarios are linked not only with quantitative illustrations of the future, but also with quantitative simulations of the path to it (in the natural and engineering sciences regarded as measureable indicators). Approaches like system dynamics may be used in those cases; resulting is a quantitative modelling and a simulation of those scenarios (cf. Döll & Vassollo 2004).
Opposite to such a use of scenarios in the engineering and the natural sciences is the scenario planning approach: For being used as a tool in societal decision making as well as in the leading and governance of financial corporations it is important to have more open structures. Real-world problems are so complex that it is not possible coming to coherent description of their future states. The scenario planning approach is most valuable when facing uncertain and complex situations with a large number of non-quantifiable factors. If there are less complex interactions and a quantifiable data-basis it is possible to combine the natural science type scenarios with simulation models.
The scenario planning approach followed here is a softer method. The scenario planning approach results in basically systematic, reasonable and traceable images of alternative futures; Usually not the most probable trends are developed with the scenario planning approach. For didactical reasons contrasting trends are developed and scenarios that might be very different from the present. Either the most contrasting alternatives are choosen for development or the most insecure (cf. Kerber et al. 2014).
The openness resulting allows to train decision-makers, managers and stake-holders in anticipating different future development and in improving creative, comprehensive and strategic thinking. The developed storylines are no proposals how to behave in the future but the hope is that they "might aid in avoiding decision error in complex processes" (Chermack 2004). The main goal of any scenario analysis is imagining future states and anticipating future developments of society (and its physical relationships), thus to help the decision-makers and stake-holders in identifying strategies for responding to these developments and in evaluating those strategies (Peterson et al. 2003, Pinter 2013).
In order to let decision-makers, managers and/or stake-holders develop or to improve strategies one must not forget a further step of the scenario analysis their "transfer" by those acting in the future (cf. Kerber et al 2014). Scenarios allow decision-makers, managers and stake-holders to learn future (re)acting by anticipating different future possibilities and their own acting in such situations. It is also possible to go to potential decision situations in order to make choices by anticipating time-frames beyond the immediate future and (path) dependencies. Thus scenarios promote a strategic planning: They set a framework to test different strategies and identify important influencing factors. They also provoke and improve communicating different future alternatives thus preparing those in the process with better insights. One assumption of strategic planning towards future developments is that future developments are unpredictable, but certain events are predetermined. Corporations like the petrochemical multi Royal Dutch/Shell have used scenario planning successfully (Peterson et al. 2003, Pinter 2013). In our study we used the scenario planning approach as it is has been developed in future research (Bishop et al. 2007, Steinmüller 1997). For scenario planning, there is not one single scenario technique, but the methodology used by Shell is acknowledged in future research as well as in the applied fields. We followed the approach as laid down by Kerber et al. (2014) thus concentrating on developing storylines of different futures in a participative manner. The quantitative data used to illustrate those storylines have not been processed in com-

puter models. The data are roughly estimations and based on long-time experiences of the authors and some local experts. Therefore the scenarios and their storylines can not be regarded as results of a quantitative modelling.
Thus the scenario planning approach allowed complex considerations but the reader has always to consider that the linked figures are not a result of computional calculations. Therefore we used figures which are general. It is suggested to use for more precise illustrations the Water Management Tool developed in the German-Iran project on “IWRM in Isfahan” (cf.Mohajeri et al. (2014) which might be suitable analyzing the interactions between surface water flows (use) and groundwater recharge. During the first phase of this project (ending June 2014) it was not possible to underline the scenarios with such calculations due to pragmatic reasons. First simulations of the scenario are to follow within the next months.
In his exemplary evaluation of foresight methods based on innovation management needs Pinter (2013) showed that scenario planning leads to more creativity in solutions and allows also to deal with complexity in a sufficient way. It has a higher acceptance as simulations or delphi methods who have been evaluated as more robust.
Scenarios very often combine qualitative and quantitative elements, i.e. storylines that tell about alternative plausible futures with selected quantitative interpretations of the outcome of the measures and interventions described in the storylines; it is planned to complement later on the scenario with simulative illustrations calculated by the Water Management Tool developed in the “IWRM in Isfahan” project.

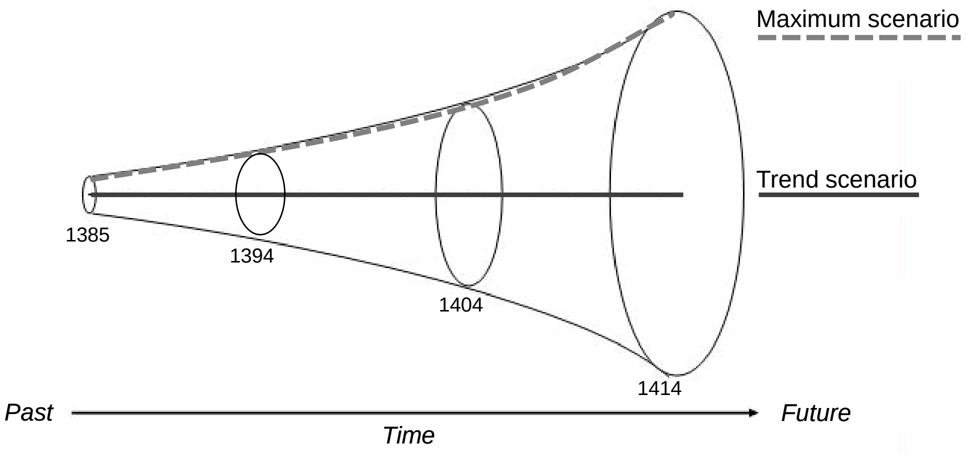

Figure 1: The scenario funnel (Source: Kerber et al. 2014, modified)

In the last years instructive experiences have been made with participative scenario development approaches. In those cases practical actors in the field and even the stakeholders (e.g. the main water users) are involved in the scenario development process at different stages (cf. Kerber et al. 2014). Usually they support the identification of the main drivers of the scenario and give hints regarding the suitability of the storyline and the measures of the scenario. Thus practical knowledge is integrated in the scenarios.
A participative development of scenarios does not only make the scenario more robust. It also allows that the stakeholders come to a better identification with the developed scenarios. This is the prerequisite of strategic planning and of a (mutual) learning of possible interventions and measures to improve the actual situation and the future.

2.2 Backcasting

Forecasting is the process of predicting the future based on current trend analysis. Backcasting approaches are the challenge of discussing the possible path to the future from the opposite direction and reason from a desired future situation. Therefore backcasting scenarios are also normative. They are based on a number of different strategies or measures to reach this situation. In the backcasting process the main question therefore is how desirable futures can be attained. First used for the problematic of the future energy supply the backcasting approach has developed in the past 20 years and is nowadays uses also in the sustainability research (Quist 2007) and even in water management (Kok et al. 2011, Mitchell/White 2003).
For the development of the Maximum Scenario the backcasting approach was chosen. Understood as a participatory process (Carlsson-Kanyama et al. 2008, Kerber et al. 2014), the fundamental question of backcasting was put to the stakeholders: "If we want to attain a certain goal (e.g. more water for the natural ecosystems in the basin, water security for all users), what actions must be taken to get there?" (The answers of the participants on a specific workshop in Isfahan on February 19. 2013 were the base of the development of the Maximum Scenario, cf. chapter 2.4).

2.3 Impact assessment

The measures of the scenarios as well as their outcome and their impact are considered as being linked in an output – outcome – impact chain, as it is used very often in the project evaluation (cf. Crawford, Bryce 2003). The output describes the technical results of the scenario interventions/measures (= the input). The outcome asks for the direct effects of the scenario interventions. Impact means the long term consequences in the catchment area (they are usually caused by more than one specific outcome).

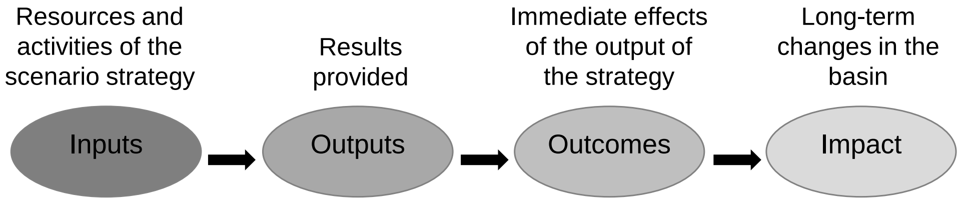

Figure 2: Input-output-outcome-impact chain used for scenario assessment

Outputs, outcomes and impacts are identified with the help of such a causal model and investigated with the help of impact assessment approaches. Regarding the output we concentrated on the question of water security (water demand and resource situation) which is regarded as the physical base for the development in the catchment area due to it's hydrological "closedness"; in future studies the output analysis may be complemented by assessing the socio-economic development more in detail (e.g. financial or social conditions). Although many assessment procedures take place under the aegis of one or more scientific disciplines – or more precisely, they are backed up by disciplinary (and to some extent also interdisciplinary) scientific expertise – they all involve, in addition to scholarly knowledge, knowledge from practice and also the validation of political or other normative (value) questions. Since scientific analysis in the strict sense can make no statements about whether something is of value the development of assessment procedures depends on assumptions about the value of public goods, on the negotiations over and balancing of interests, and on an assessment of risks and dangers (and thus it depends also on nescience or non-knowledge). Experts from the sciences, politics, professional and business associations, and other stakeholders may participate in this process (it was not possible to broaden up the perspective in our assessment because of pragmatic reasons).
Since often a number of heterogeneous criteria must be taken into account (e.g., scientific plausibility, technical feasibility, cost effectiveness, legal structuring, organizational manageability or social acceptability), modeling within a multi-criteria assessment procedure plays a central role, both in terms of its integration effect and in terms of the systematizing effect it can have on the way in which the problem under study is perceived. Commonly in use are both quantitative and qualitative approaches, though the latter generally promotes better communication among those participating in the research project, and thus mutual understanding of other areas of knowledge and of the contribution of others to the research project's results.

Although common assessment procedures (such as environmental impact assessments) generally refer to individual (investment) projects, it is also possible to ask for the outcome and impacts of overarching and longer-term strategies, as conducted in the outlook scenario and the Maximum Scenario. Impact assessments have a special focus on the specific impact effects of the measures planned for the assessed project (e.g., profitability, cost reductions or expected environmental impact). It is also possible executing a cross-sectoral judgment which, for example, could also include consequences for society (cf. Bergmann et al. 1999). At rhe end of the assessment was a subjective evaluation executed by the ISOE team considering the impact on the three key dimensions of sustainability: Society, economy and ecology/environment. It was not the aim to describe exactly the impacts of each scenario to society, economy and ecology but to gain some first ideas of what might happen in order to see where the ideas developed in the scenarios need to be changed for coming to desired impacts.

2.4 Participation in the scenario development and first validation of the storylines

Developing scenarios in a participative process affords to share perspectives and different points of view by those who should be involved in the shaping of the future water management. Participatory scenario development is an established approach (cf. Bohunovsky et al. 2011, Reed et al. 2012). That process requires the participation of stakeholders to explore the future in a creative and policy-relevant way. A number of expert meetings and workshops have been held to support the scenario developing process in a participatory way. In Appendix A of this report you can find a list of various meetings and their participants.
In February 2013 a two-day scenario planning workshop was held in Isfahan. Objective of the meeting was to discuss and verify with the various stakeholders the general ideas of the scenarios, to develop them further with material and essential elements, and to rank the major drivers which have a significant impact on the Zayandeh Rud basin management in future and therefore should be used in the scenario development. In Table 1 you will find the major drivers as ranked by the workshop participants.

Table 1: Drivers ranked as highly relevant for scenarios development by the workshops' participants

Driver	Subjects
Policy making	Sustainability orientation, different IWRM framework and water price in various scenarios
Economy	Considered by action of the regional stakeholders
Climate	Stakeholders are aware that extreme events (drought, storms, etc) change maneuver. Very different modes of reaction are included in the three scenarios.



A few impressions of several meetings and workshops hold in Isfahan

Those drivers have been the starting point for ISOE's systematically scenario development based on the suggestions of the participatory process. During the course of the year 2013 further meetings with key research persons and stakeholders made us aware of points that should be improved in our scenario sketches. Thematically we like especially to mention the closed basin problematique[1] and its appropriate irrigation measures (cf. Falkenmark/Molden 2008) as well as the agricultural cultivation patterns, the social impacts of all transitions from a smallholders' agriculture to modern agricultural production systems and the responsibility for the shared water security risks of all water users in the Zayandeh Rud catchment area. Due to the support of the participating stakeholders the scenario development can be perceived as an iterative process, although the responsibility of the resulting scenarios remains to the authors of this report.

3 Data base used and definition of the scenario field

For scenario developing we used many data and studies such as

- statistical data gathered and published by the Statistical Center of Iran
- Jamab consulting engineers company (2005): Studies of integrated adaptation to climate change, balancing between Water resources and uses in the watersheds; Current and future state of water resources in Zayandeh Rud river basin. Ministry of Energy, Water and Sewage Deputy, Office of macro water and sewage Planning. 2 Volumes
- Water and sustainable development Consultants Company (2010): Updating the studies water resources atlas for Gavkhouni river basin. Ministry of Energy, Isfahan Regional Water Company. 21 Volumes.
- Yekom consulting engineers (2012): Updating of water master plan in Gavkhooni watershed. Ministry of Energy, Water and Sewage Deputy, Office of macro water and sewage Planning.
- Zayandab Consulting Engineers Company (2008): Study of water resources and water consumption in the Zayandeh Rud Basin.
- Isfahan province industry and trade organization (2012): Strategic document for Industrial, mining and trade sector of Isfahan Province in the fifth development plan (1390-1394).
- The Islamic republic of Iran's fifth economic, social and cultural development Plans.
- Isfahan governor's office (2012): Report about evaluation of achieving the goals of 20-year outlook plan for Isfahan province (1384-1388).
- over 30 articles in international scientific journals

The data collection and analyzing process was done in a longer time frame than planned, because we had to evaluate a variety of studies having been conducted in Zayandeh Rud catchment area and many more data submitted by the Water Authority (ESRW) and the Isfahan Agricultural Organization; in several cases we had to deal with incomplete or even conflicting data. Although much time was invested in analyzing and evaluating the collected data, we gained a sufficient database only by repeated discussions with experts in Isfahan. We also used the reports from the joint project's sector modules and coordinated professionally with the experts in Germany and Iran. All together, we assume that we have an optimistic interpretation of the situation in catchment area.

Due to pragmatic reasons the base year of each of our scenarios is the year 1385 of the Iranian calendar (i.e. 2005). The Iranian project partners and stakeholders agreed, that 1385 was a climatically "normal" year and is to be determined therefore as a base year.

The running time of the scenario is a time span of 20 years, so the scenarios end in 1404. The scenario area is the whole catchment area of Zayandeh Rud (not only the part in Isfahan province), There is one exception: The observed parameter "consumption of drinking water" exceeds the catchment area; included is also the water for the urban regions outside the catchment area (because this larger supply area is supplied with water from Zayandeh Rud).

[1] Although the Zayandeh Rud basin is a closed or endorheic basin (=basin without outflow), this hydrological meaning of the term is not used in this report. We use here the term „closed basin" (or „closure of basin") in the way as it is scholarly done in water resource management for overbalanced river basins. i.e. there is a closed resource allocation, because resources are so short that it is not possible having resources for new users nor sufficient water for the environment. Molle & Turral (2004) identified the Zayandeh Rud basin as being a closed one in that sense.

In the scenario development the consideration of observable events (like the drought and the peasants reactions) was neglected. Drought, normal or wet weather are statistical events; and it ist not easy traced back to changing climate. The Water Management Tool allows simulating different weather situations in relation to the normal state (trend) as well as to other scenarios.[2]

The agricultural patterns given in the appendix B are derived from the three scenarios. They should not be misunderstood as proposals for agricultural action. Their aim is to allow simulation with the Water Management Tool in order to have better data for the assessment of output and impact.[3]

4 Trend Scenario

4.1 Storyline of the Trend Scenario

Due to recurrent droughts in the catchment area, there have been long periods of water scarcity which have led to numerous complaints and demonstrations – because people have attributed the water scarcity not to the absence of rainfall or to too many claims on regional water resources, but simply to bad management. Kicked off by the increasingly difficult situation with regard to water resources, till 1393 intersectoral discussions were already occasionally held, in which water management issues in the catchment area and the distribution of water between the sectors were also addressed.

Only on the same, yet very low level, there are intersectoral discussions in the catchment area during the following years. No group of players is willing to systematically initiate intersectoral discussions in the next years. During events in which the future of the Zayandeh Rud is discussed, at best the intentions and plans of the individual sectors are jointly discussed, but this never leads to a referendum on these plans. In the catchment area, developments continue on parallel trajectories. All the sectors pursue their plans for future development independently of one another (according to their Outlook plan as well as the five-year national development plan). This approach allows them all to retain the greatest possible autonomy in their activities, but doesn't create any new options for concerted action. These factors all still weaken the protagonists in Isfahan Province and mean that there will be no fundamental changes in the distribution and use of water. There are also recurrent complaints about the lack of a coordinated development plan with regard to the shared use of water resources by the provinces of Isfahan and Chaharmahal va Bakhtiari, but this ultimately leads to tensions between the key players of both provinces increasing to such an extent that there are no joint initiatives.

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2 In the comments on the previous version of this report some stakeholders and experts suggested developing scenarios for normal, dry and wet years resp. considering the recent drought trend and the data related to the last years instead as using the defined base year as origin of the scenario. The scenario planning approach is not an approach using an observed reality to calibrate scenarios as it is done in simulation models.

3 Such a modelling with the Water Management Tool has not been done yet. It allows to find out the water demands and the economic effects of the agricultural patterns in appendix B which are only one (of many) possible illustration of the three scenarios. Estimations of their (unintended) effects will be possible afterwards, e.g. in regard of a central management of irrigation water without decentral buffers or to more flexible forms of irrigation water management.

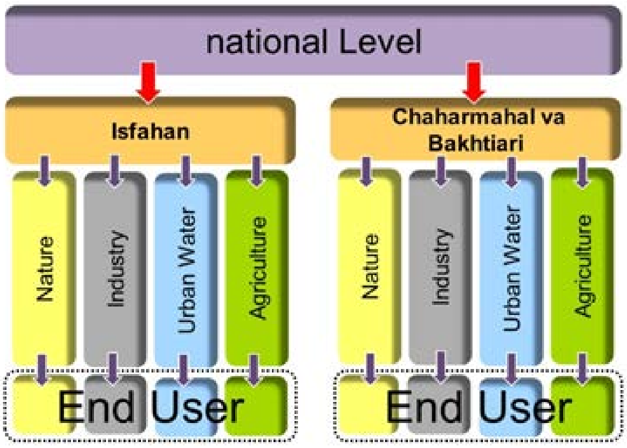

Figure 3: Organizational concept of the Trend Scenario

4.2 Output of the Trend Scenario

The mentioned political measures will lead to the following responses of the actors:

- In the catchment area, most players still seem to think it sufficient to conform to the pre-existing method of distribution for water crises (there is also no intermediary institution which would support change and/or develop constructive proposals for it).
- In the catchment area, the modernisation of agriculture and the increased use of new farming methods are only taking place to a very limited extent, with innovations being implemented mainly according to the capital resources of the respective farmers and/or their access to state subsidies. The portion of the agricultural sector which has sufficient capital and know-how will, following global precedents, modernise production capabilities. This modernisation will begin by intensifying the cultivation of higher-value products (poultry, beef, mushrooms, vegetables); there is even a partial conversion to a quasi-land[4]less industry. The innovations are not based on saving water, and conserving water is only achieved indirectly, due to the adoption of specific technologies (e.g. greenhouse cultivation) and cropping. Usually, smallholders will not innovate, especially since the activities of the (supporting) innovation programme of the master plan almost all point towards concentrating operations.
- Size of the agricultural acreage: Due to several years of sufficient rainfall and thus a periodic improvement of the water situation, starting in the year 1400 there is an increase in agricultural acreage (compared to 1385). This leads to an increase in the demand for agricultural water which is balanced only by slight modernisation.
- The structure of regional industry is modernised following some goals of the master plan (development of high-tech and eco-friendly industries). However, to achieve this, players usually need to make investments themselves. State support for investments can partially strengthen this direction of innovation.
- Although implementing state-of-the-art water-saving technologies is in the companies' self-interest (reconnection to global competitiveness), due to very low water prices there are initially no economic incentives to prioritise making these investments in the case of groundwater extraction (essentially only the pumping costs with subsidised energy), and only few incentives in the case of surface water use (from the channels).
- Only few industrial parks are being built. Due to lack of spatial planning and incentives, only a few regional companies are settling there (who want to have better sites).
- The urban water management sector sees its main task as building wastewater treatment plants in urban areas, and in increasing the degree of connectivity in rural areas (both for wastewater and for over a

[4] For instance, intense poultry breeding with high numbers of lifestock not dependent on the size of the land available to the breeder (so he is buying forage from other farmer, even in other regions or countries).

hundred communities that are not yet connected to the drinking water supply) after ensuring the central supply. Drinking water consumption in the region increases 21%, commensurate with the growth in population and degree of connectivity.

- Leakage management leads to a reduction in water losses by 2% and thus in per-capita-water-consumption, with a target of 133 l / person / day defined in the master plan.
- Within Capacity Development programmes, there is no practical training in technical, administrative or commercial fields. This applies to all sectors equally, which only offer “theoretical” courses to train staff.

4.3 Outcome of the Trend Scenario

Due to the mentioned output of the scenario in the different sectors the outcomes listed in tables 2–4 occur (cf. also the explanations in the following chapter on impacts). Most of the presented outcome figures might be put as input when proving the (hitherto only roughly estimated) real water use in the basin with the help of the Water Management Tool.

Table 2: Outcomes of the Trend Scenario regarding the residential water sector

	1385	**1404**
Population growth rate compared to 1385	100%	127%
Water prices	subsidized prices	subsidized prices
Resulting (inflation-adjusted) price of water compared to 1385	100%	100%
Reduction through the application of water-saving technologies [%]	0%	less than 3%
Water losses combat strategy	none	neclectable
Water losses [%]	25%	23%
Consumption of drinking water supply in the supported area [Mio. m3]	365	462
Drinking water consumption in the catchment area [Mio. m3]	300	381

Table 3: Outcomes of the Trend Scenario regarding the agricultural sector

	1385	**1404**
Cultivated areas [ha]	250000	270000
Cultivation patterns	90% crops / vegtables 10% fruits	no change
Water prices	subsidized prices	subsidized prices
Irrigation Strategy	based on sufficient amount of irrigation water	based on available irriga-tion water
Irrigation Technology [ha]	drip irrigation: 4,000 sprinkler: 16,000	drip irrigation: 6,000 sprinkler: 20,000
Observed agricultural water extraction [Mio. m3]	5100	5100
Real water use [Mio. m3]	2100	2100

Table 4: Outcomes of the Trend Scenario regarding the industrial sector

Impacts of industry sector	**1385**	**1404**
Industrial growth	100%	120%
Water prices	subsidized prices	subsidized prices
Saving technology	minimum	minimum
Industrial water consumption [Mio. m3]	150	180

4.4 Impacts of the Trend Scenario

In the Trend Scenario there is no combatting of the water risks in the catchment area. Therefore in future the water balance is not equalized but the basin's water demand is higher than the sustainable water yield. Especially in drought years the question of the water deficit will dominate the agenda; there will be the risk that the present allocation scheme privileging residential and industrial water supply might be changed. Zayandeh Rud has not enough water; and the quantity problem is accompanied by quality problems: Downstream Sad Tanzimi the river is no longer in a good chemical state. One reason therefore are high concentrations of livestock in some areas. The animal breeding resulted a disposal of the slurry as "liquid manure" on fields of forage maize. In some of those regions there is also an extremely high pro rata share with alfalfa and clove.

So insecurities of water availability are enlarged by the high loads of the surface water downstream with various chemicals (salts, nutrients, pesticides etc). The insufficient water security is regarded as an investment risk for economic development.

Especially the traditional part of the agriculture and its smallholders will be the losers of permanent crises of agriculture. As a result parts of the arable land will be given up in the next series of drought years; the resulting loss of cultivars has impacts on agro-biodiversity. Without socio-economic perspective there will be a socio-cultural uprooting of those traditional farmers with abandoned farms and farm workers set free. There is the risk of civil disturbance on the one side and of a strong emigration to other regions on the other side.

The strategy of modernising agriculture which has been adopted to date will also lead to problems with water quality in the long term, if there is no success in promoting the idea of integrated plant production or even of organic farming. Appropriate training courses are being held, but it is becoming clear that so far there is no sufficient knowledge base for both cultivation methods in Iran, nor are there any possibilities to specially market these premium products.

Instead of combatting against the basin's closure until 1400 all water users agree to bring water from the Caspian Sea to Isfahan (due to problems to get enough water out of the Karun region after stronger protests and an interdisciplinary evaluation of the impacts of water withdrawal for Kashan). A consortium developed a plan for a pipeline project but it turned out that its energy demand (and thus its operating costs) are far too high.

5 Jointly Modified Outlook Plan Scenario

Detailed scientific studies have shown that the situation in the catchment area has become difficult due to previous over-exploitation of most water resources, with intense usage leading to a “closedness of the basin” (see Keller et al. 1998). For this reason, even the projected new water transfers from the adjacent catchment area of Karun river will only be able to guarantee future development if the relevant water-using sectors in the catchment area coordinate their developmental goals with one another. Based on these considerations, sector representatives introduced their master plans to each other at a workshop on February 19th 2013 in Isfahan. During the meeting they also set these plans in relation to the existing water supply and developed ideas about how coordinated development might take place.

5.1 Storyline of the scenario “Jointly Modified Outlook Plan”

For the catchment area the central government allows the Outlook Plans of the various regional sectors to be coordinated with each other. Funding tools, especially subsidies of the authorities responsible, may also be correlated with one another. This approach leads to a process in which the master plan can be better coordinated between the three sectors. Preliminary talks between the Water Authority, the Industry Authority, the Department of Agriculture and the governor of Isfahan Province are very constructive and are helping pave the way for this process.

The protagonists already agree in 1395 that the planned-economy targets for the various sectors can only be met if agriculture freezes its irrigation and land requirements at the level of 1385, but also only if industry makes no further demands for water.

After positive experiences in 1395, the intersectoral talks in the region are consolidated. The sectors hold annual joint conferences, during which expectations are discussed together. When the master plans for the various sectors are updated, these are better able to be coordinated with one another. The results of the annual talks form the basis of an IWRM process managed by the Water Authority.

The understanding of this IWRM process is strongly influenced by the specialists from the Water Authority. They see the process as a management process and see themselves as the managers of the process. Beyond the annual stipulations (”Jointly Modified Outlook Plan”), they factor in the comments and suggestions of the stakeholders as far as they deem them appropriate. The Water Management Tool is also operated by specialists from the Water Authority who determine operation alternatives on behalf of the managers (which also helps resolve sector issues).

With the help of annual talks, the Water Authority in Chaharmahal va Bakhtiary is also informed about the IWRM process.

This IWRM process is promoted with the help of the following measure which was introduced independently of the regional process: In 1394 the Iranian Parliament decides to introduce cost-covering water prices in several stages, due to the water shortage in some provinces (e.g. Tehran, Urmia). Initially, the price is raised by 20% until 1404, not only for water from the water utilities in the provinces, but also for the generated channel water which is used by many industries and agriculture in the catchment area. To achieve actual cost coverage, the Water Authority water- and wastewater utilities and the Mirab-organisation, are requested to ensure cost transparency.

Figure 4: Organizational concept of the Jointly Modified Outlook Plan Scenario

5.2 Output of the Jointly Modified Outlook Plan Scenario

The following outputs in particular deserve mention:
Modernising agriculture while applying more new farming and irrigation methods, with innovation is happening primarily when there are sufficient capital resources. As a result, smallholders will hardly be able to innovate. Following international precedents, the rest of the agricultural sector will enter a process of restructuring which aims not only to increase the use of modern farming methods, but also to concentrate production structures (the innovation measures anchored in the master plan have a supportive influence here). Initially, the innovations themselves are not focused on conserving water, but are targeted towards improving agricultural structures. Their goal is to increase the cultivation of plants with a higher added value (mushrooms, fruits, vegetables, pistachios, saffron, sesame seeds, herbs and natural medicines such as cumin, camellias, aloe vera), but the intensive livestock breeding also increases. Indirectly, water is conserved due to changes in technology (e.g. advanced greenhouse cultivation).

- Due to the modernisation measures, the amount of agricultural land and sectoral usage remains at the level of 1385, commensurate with the results of the workshop of February 17th.
- In urban areas, the urban water management sector is focusing on rehabilitating crumbling networks (reduction of network losses to 20%, from over 25% previously). In rural areas, measures are concentrated on increasing the connection rate. Sporadically, water-saving technologies are also used (by replacement investments in the field of aerators, flush toilets or shower heads).
- In addition, more plants to treat municipal wastewater are built, and existing systems are rehabilitated, with the new sewage treatment plants designed so that the wastewater can be reused in agriculture (in areas far away from rivers, too). The legal framework is improved and technologies are also tested to help improve systems management.
- Designating and settling industrial parks functions according to the Outlook Plan, leading to industrial growth in the catchment area. The intersectoral arrangements bring security for investors, leading to high-tech industries also establishing themselves on site, and to an increase in the number of employees.
- Investment funding delineated in the master plan is initially used, after consulting with the other sectors, to assist the industrial and commercial sectors with production-integrated environmental protection programmes, thus also leading to a further reduction in water consumption. Implementing state-of-the-art water-saving technologies is in the self-interest of industry and commerce (global competitiveness) and is achieved according to capital resources. This results in savings of up to 10%.
- In industry, there are attempts to support the establishment of water-extensive production (including administration and logistics) in particular. The governor of the province issues a corresponding directive, and investment funding from the master plan is used accordingly. Despite an annual revenue growth of 2.5%, there is a growth in demand of 100% (compared to 1385).

5.3 Outcomes of the Jointly Modified Outlook Scenario

In difference to the output of a scenario its outcome means the extent to which the specific objectives of the scenario are achieved. Due to the mentioned output of the scenario in the observed sectors the outcomes listed in tables 5–7 will occur (cf. also the explanations in the following chapter on impacts). Most of the presented outcome figures might be put as input when proving the (hitherto only roughly estimated) real water use in the basin by using the Water Management Tool developed by DHI-Wasy during the German-Iranian joint project "IWRM in Isfahan".

Table 5: Outcomes of the Jointly Modified Outlook Plan Scenario regarding to domestic water supply sector

	1385	**1404**
Population growth rate comparedto 1385	100%	127% (migration?)
Water prices	subsidized prices	operation cost covering prices
Resulting (inflation-adjusted) price of water compared to 1385	100%	120%
Reduction through the application of water-saving technologies [%]	0%	15%
Water losses combat strategy	none	minimum
Water losses [%]	25%	20%
Consumption of drinking water in the supplied area [Mio. m³]	365	354
Drinking water consumption in the catchment area [Mio. m³]	300	292

Table 6: Outcomes of the Jointly Modified Outlook Plan Scenario regarding to agricultural sector

	1385	**1404**
Cultivated areas [ha]	250000	250000
Cultivation patterns	90% crops / vegetables 10% Fruits	76% crops 14% vegetables/ flowers (10 % greenhouses) 10% gruits
Irrigation strategy	based on sufficient amount of irrigation water	based on optimum plant requirements
Irrigation technology [ha]	drip irrigation: 4,000 sprinkler: 16,000	drip irrigation: 10,000 sprinkler: 20,000
Observed agricultural water extraction [Mio. m³]	5100	4800
Real water use [Mio. m³]	2100	2050

Table 7: Outcomes of the Jointly Modified Outlook Plan Scenario regarding to industrial sector

	1385	1404
Industrial Growth	100%	165%
Saving Technology	minimum	In existing industries: Environmental protection: partly production integrated New industries: Water extensive with saving potential
Industrial water consumption [Mio. m³]	150	260

5.4 Impacts of the Jointly Modified Outlook Plan Scenario

Water tariffs

In the context of a closed basin situation, the water and wastewater tariffs play a crucial role. The higher tariffs are, the higher is the economic driver towards a rational and efficient water use. This scenario deals with a moderate increase of the water prices. It is not very likely that such a moderate increase will be effectual for a change in entrepreneurial action (e.g. investing in water saving technologies or even in the water use behavior. In the industrial sector there will be some effects in water-intensive branches (e.g. in dairies or in the beverage industry), but not in all (e.g. slaughterhouses and butcheries, cf. ECOTEC 2001). Water demand management through prizing is effective for reducing domestic supply and also in parts of the industrial sector, but the case in the agricultural sector is much more difficult (cf. Molle 2008).
The increasing of tariffs is comparatively low, so it might affect the households only. The increased tariffs will not have the intended effect on agriculture. Even tariffs increased much more would only affect farmers using surface water for irrigation. With the help of higher tariffs it is not possible to influence those water-users extracting groundwater, because those water-users (farmers as well as industry) have their own wells being operated in most cases with the help of pumps. But agricultural and industrial use of groundwater is as least as sensible as their use of surface water. Thus the tendency to exploit non-recharging groundwater resources is not interrupted in the Jointly Modified Outlook Scenario.

Agricultural perception of industrial development

According to our interviews with farmers and agricultural experts in the catchment area, they have a very high sensitivity with regard to industrial development in the catchment area. During the preparatory workshop to develop this scenario and also during conversations both in Iran and in Frankfurt/Germany, there were repeated demands to modify the production process to reduce water consumption in all sectors equally. Like Mr. Kermani, the agriculture produce deputy of Isfahan’s Agricultural Organisation other people also critically asked: Why should agriculture conserve water, when there are no behavioural changes in industry?

Horticulture as modernisation measure

Especially in the eastern part of the catchment area, the low fertility and productivity of the soil, combined with the questionable supply of irrigation water, lead to very low land prices. Like in Almeria in Spain, farmers and development agencies will be able to buy this land to operate greenhouses, if this form of cultivation is considered to be industrialised and if, like industry, it receives sufficient water, even in dry years. The eastern part of the region might transform itself into a “vegetable basket” for the Middle East, if the water is clean enough and horticulture is using artificial substrates like stone wool instead of the (poor) soils. Using methods of desert horticulture, arid areas thus might turn into a region with high added value.
At present the total of greenhouse cultivation in Isfahan province is 1100 ha. The expansion of the acreage destined for greenhouses to 25.000 ha is an enormous challenge; fundamentals are sufficient water resources as well as investment funds and a solid capacity building.[5] This expansion process should be regulated and controlled by

[5] The Agricultural Organization is also emphasizing scientific research whereas we believe it is sufficient to organize an international knowledge transfer of greenhouse research and of experiences in regard to agricultural capacity building.

the state (from the perspectives of the agricultural, water and environmental authorities). Otherwise the higher number of greenhouse farmers with their intensified cultivation (and thus higher water amount in relation to the greenhouses' area) may lead to more pressure on water resources than before the introduction of new farming techniques; this is what happened in Almeria in Spain (see Sánchez-Picón et al., 2011).

When there is excessive greenhouse cultivation with acreage concentrated in a limited space, there is a threat of significant environmental problems in the regions concerned (see Schramm, Kickler 2014), if the horticulturists follow a "conventional" agricultural production instead of at least an "integrated production" (or even forms of organic horticulture, that has been developed during the last 4 decades in some countries). Poor villagers and also unskilled workers from other parts of Iran might migrate into the expanding regions. This might result in the formation of chaotic states of urbanisation, which would bring social problems, but also additional environmental burdens. Thus there is a social-ecological risk which, however, might be averted through intelligent state regulation with a functioning executive. The institutions that are needed to achieve these kinds of unintended negative developments are not initially provided in the scenario. These are the introduction of a spatial planning institution, a licensing requirement and penalty mechanisms (when violations occur), as well as setting minimum wages.

Over the long term, the strategy of modernising agriculture which has been adopted might also lead to problems with water quality. One alternative might be to develop organic farming. It is unlikely, however, that there are farmers in this scenario who will pursue this strategy. The concomitant industrial and distribution structures which are necessary to market products from organic farming are only established in the Maximum Scenario.

Irrigation technology

Sprinkler technology was spread during 1385 and 1390. It will not be pursued further due to the high evaporation rate, sometimes difficult operation conditions and other negative experiences. Micro irrigation systems (also called trickle irrigation or localized irrigation) will mainly be introduced not only where orchards are situated but also where closed greenhouses will be implemented. Surface irrigation is also suitable for the provision of fields where groundwater wells of good quality are used.

There are some unintended effects coupled with those advanced irrigation technologies: In some cases (e.g. in the western part of the catchment area) the thus saved water amount was used by the farmers and gardeners to increase their agricultural areas. Therefore in such cases the introduction of micro irrigation did not lead to a reduction of the agricultural water demand; the improved water efficiency was not used to solve the allocation conflicts in the basin and to improve the "closed" resources situation (Falkenmark/Molden 2008), but to privatise the water "win". From the perspective of water management experts in the basin, at least in those parts of the basin with surface as well as ground water extraction growing fruit as well as the introduction of water efficient drip irrigation makes little sense. Growing fruit is rumoured to have high water consumption and farmers see increased risks, because if over a certain period there is no water available for irrigation, the trees die and thus their capital is destroyed. Because of the "closed basin" situation, it is controversial whether micro irrigation systems have a positive effect, since there is no groundwater recharge under the fields that are equipped with such a water efficient irrigation technology (cf. Molle/Turral 2004).

Social effects of water insecurity

In future, the conflicts between the agricultural sector and the Water Authority will worsen in this scenario if there are several dry years in a row, because then there will no longer be enough water. During this kind of dry period, if situations of scarcity occur again in spite of the new transfer channels, it will be necessary to take a very clear stance in the IWRM process. The view of the Water Authority that the modernised agricultural plants can be understood as "industrialised" and thus should be privileged compared to other forms of agriculture, just like industry, may lead to an uprising in the remaining agricultural areas. Here it might make sense to use the annual conference of the sectors in the catchment area of the province to promote the Water Authority's standpoint.

As an unintended effect the number of farmers might decline. As a by-product of the cultivation of field and garden fruits, in the past the farmers contributed significantly to the environmental protection of the basin. With the agricultural vegetation cover they protected the soil from water and wind erosion and maintained its filter and buffer capacity for groundwater recharge. They also contributed potentially to carbon sequestration in the soil humus.

We suggest to do so with the help of a series of international workshops and summer schools with participants from all relevant MENA countries including Turkey.

Roughly estimated in the basin the total water demand in the basin will be often above possible water yield. So there will not be enough water for a restoration of the aquifers or Gavkhouni. In a series of drought years Zayandeh Rud will not have constantly water. Therefore crises of tourism and also of (parts of the) agricultural sector will occur periodically. They might led to some emigration to other, more prospering regions in Iran or in neighbouring countries.

Water quality

Water quality is increasingly becoming an important issue. Consequently, collaboration between the industrial and environmental authorities needs to be strengthened in order to establish only those industries whose wastewater doesn't pollute the Zayandeh Rud. Like Isfahans environmental authority, the regional water authority needs to be actively integrated in order to avoid the establishment of water-intensive industries and/or ensure that appropriate technologies for efficient water use are put into place from the outset.

6 Maximum Scenario

6.1 Storyline of the Maximum Scenario

At the end of a five-year drought period in the catchment area of the Zayandeh Rud, in 1393 the central government suggests convening a round table to discuss the prospective sustainable development of water management, and to make this the core of an IWRM process which includes both provinces. At first it is set up for a period of ten years for water use in the catchment area of the Zayandeh Rud. Essential key stakeholders from all groups of water users in Isfahan Province also recognise that, given that the situation has been precarious many times, they can no longer achieve sustainable development in an uncoordinated manner (and thus potentially, albeit unintentionally, against each other), but only jointly and with a concerted effort. So there is a great willingness of all sectors to participate. However, the representatives from Chaharmahal va Bakhtiari do not take part in the first sessions in Isfahan. At the suggestion of the central government, the Water Authority and the Department of Agriculture of Chaharmahal va Bakhtiari are again explicitly invited to take part in the Round Table and the IWRM process arising from it. Now stakeholders from the part of the catchment area which is located in the neighbouring province of Chaharmahal va Bakhtiari also participate.

A new statutory provision allows both regional planning proposals as well as action proposals to be developed at the Round Table, which are used to achieve sustainable development in the area. This also allows specialised agencies from both provinces to give the Round Table appropriate input. For the IWRM process, the agency leaders have flexible options for complying with the votes and decisions discussed at the Round Table whenever possible.

For sustainable development, water quotas which have been jointly agreed on don't just need to be made available to all water users so that sustainable economic development is still possible – in the long run the current water balance in the region, which is badly disturbed, needs to return to a balanced state. The regional water balance is an important indicator for this.

The Round Table has the following tasks:

- To help create an IWRM process across the provinces that encompasses the entire catchment area, with the objectives of water conservation (capping of consumption) and redistribution between the sectors;
- To develop joint innovation programmes at the sub-catchment area level and to set the framework for advising investors on water-saving technologies and desirable forms of production;
- To prioritise business investment measures in the three sectors;
- To develop and support specific funding measures. On the one hand, these funds flow from the water consumption tax for all sectors which was newly introduced for the catchment area for a limited time period in 1394 (see below). On the other hand, funds from the Ministry of Energy, the Ministry of Agriculture and the Ministry of Industry are bundled where possible.
- A Water Allocation & Trading Board for the catchment area, which is established at the Water Authority, permits trade with the groundwater abstraction rights between agriculture and industry in certain parts of the catchment area. On the one hand, this can compensate farmers for the loss of income that can be the result of giving up agriculture. On the other hand, this may make it possible to establish in-

dustry in the eastern part of the catchment area as well. In those parts of the catchment area in which there is over-exploitation of groundwater, no trade with groundwater extraction rights will be allowed.

These measures allow an IWRM process which is supported by the following activities, which were introduced centrally and independently of the regional process:

- 1394 the Iranian Parliament decides to introduce cost-covering energy prices in agriculture and industry, too. Subsidies are to be dismantled step-by-step to avoid the consumption of too much energy and to increase revenue. Every two years, energy costs will rise by 10% (in real terms – i.e. net of general inflation affecting overall price trends) until energy prices have reached a reasonable level. After several step-by-step increases, not only will operating and investment costs be covered, but over the long term, attempts will be made to factor the economic costs of water management into the pricing.
- In the same year and due to over-exploitation in some parts of the country – in addition to the Zayandeh Rud, Lake Urmia is repeatedly mentioned – on a national level the water consumption tax mentioned above is introduced as a water extraction tax, as long as water resources are under extreme pressure. This tax was introduced nationwide for the abstraction of groundwater and/or surface water. The urban water management sector and Mirab collect the tax from their customers. The tax for well operators is levied by the water authorities who administer the generated funds in trust at the individual provincial level.

The funds will be made available to water users in a manner that benefits the general interest, for investments to reduce the amount of water extracted in the catchment area. With regard to promoting measures to reduce water extraction (and thus the handover of the fees), the water authorities are also accountable to the Round Table as part of the IWRM process for the Zayandeh Rud catchment area. On average, the price of water rises by 70%.

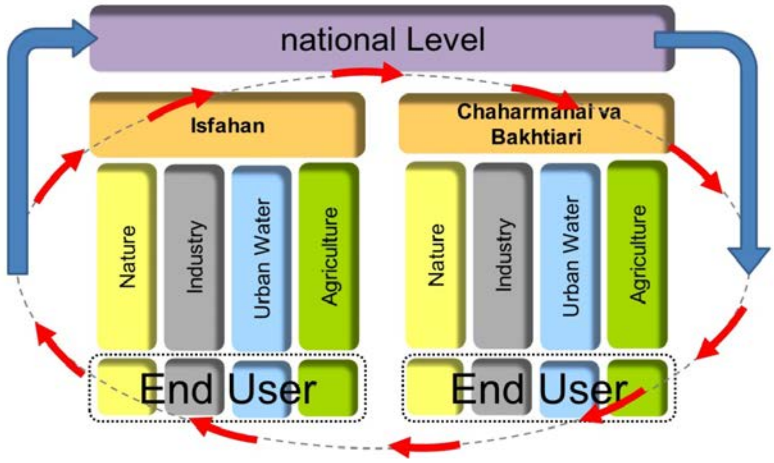

Figure 5: Organizational concept of the Maximum Scenario

6.2 Output of the Maximum Scenario

The IWRM process is designed as a learning process, focusing on collaborative learning in the catchment area. Mandatory solutions are continually being developed at the Round Table. The WMT can be used by the public. In addition to trained representatives from every sector working with the Round Table, interested lay-men and other individuals may also gain access to it.

After a detailed study of the water management model which was developed by a German IWRM project for the catchment area, the members of the Round Table decide that, due to the challenging water management situation, it would be easiest to mainly support industry and promote a conversion process in agriculture. By intensifying crop cultivation it may be possible to generate higher yields, even if twenty percent of the acreage used agriculturally, especially in the eastern part of the catchment area, is abandoned. It is being debated that the agricultural area in the province of Chaharmahal va Bakhtiari might also be limited, reducing the amount of irrigation water by 20%.

Water-intensive products should preferably be produced where water is available in sufficient quantities. The production of water-intensive agricultural products such as rice in the catchment area should be minimized as

long as a “closed basin” situation is existing. Instead, the greenhouse cultivation of vegetables is refined in such a manner that it can also be used in the eastern part of the catchment area. Generous funding of greenhouse cultivation makes the structural change economically interesting for farmers in the catchment area.
In those regions of the catchment area in which there are no or only few greenhouses and where gravity irrigation methods continue to be used, people are switching to a strategy of deficit irrigation. Concomitant measures and small decentral storage of water are necessary for this irrigation method to succeed in a controlled manner and so that harvest losses are only about 20% (see 2.3.).
Agricultural representatives strongly warn against supporting industrial expansion at the expense of agriculture. It is becoming clear to all the Round Table participants that they need to include smallholders in particular, who, under the current conditions, may be the losers in the IWRM strategy. It is becoming clear that there needs to be a pact between industry and agriculture covering the following key aspects: For the children of farmers and smallholders who want to give up their land, new jobs in industry are created that are well paid and offer prospects for the future. So that farmers who give up their land still retain a rural identity, opportunities for generating supplementary sources of income are created. In particular, they receive very low-interest loans so that they can build small greenhouses in which, after work, they can grow vegetables for their own consumption and partly for their friends and relatives.
In addition, a contract farming programme is being created in the catchment area to support smallholders willing to innovate. On the one hand, it models itself on environmental protection measures (e.g. the prevention of erosion and desertification), but also on the protection of rare species of arable flora and fauna (conservation programme). Restrictions are also being discussed with regard to industrial development. It is particularly important to preserve the endogenous potential of the region and to further develop it, so not every industry is supposed to settle there. For example, the plan is to dispense with further steel industry in the area. The priority is to establish industries which fit with the rest of agricultural production and which make it easier to market nationwide (e.g. products from organic farming).
Supported by funds from the water consumption tax, well-planned eco-industrial parks with an intelligent and crisis-resilient infrastructure establish themselves. Companies from all over Iran, who are particularly interested in Isfahan as a production site, also settle there.
The urban water management sector initiates a compelling demand management focusing on a campaign to conserve water. Due to the increase in tariffs, households begin to save water quickly with the help of simple technologies. In order to avoid social hardships, a foundation supplies shower heads and aerators free of charge to households most in need. Households also learn how they can reduce the amount of water for flushing toilets by using bricks in the toilet tanks.
Due to the existing legal framework, initially there is only little motivation to save water in the public sector. The use of water-saving devices in the field of public facilities (sports facilities, schools, barracks, mosques) is supported by a large environmental foundation.
In addition to saving water, other measures are part of demand-side management. In new urban housing areas it also includes installing a dual water supply system (greywater is processed semi-centralized and distributed for service water use as the operation of flushing toilets or the irrigation of lawns and public green) and leads to water savings of 30% (some will be eaten up by growth due to urbanisation and the demographic development). The basic idea is that water consumption in the sector will remain the same over the long term. During the next years in the drinking water supply network there is no systematically loss combat, because the operators are aware of the fact that at the moment, the losses is an intended but vital measure to artificially recharge the area’s groundwater. So till 1404, losses from the supply network are charged towards the eco-water. This should and must change later, when net losses are reduced up to 5%. Semi-centralised wastewater treatment systems for grey water are widely introduced in urban areas. After the legal requirements have been modified, water/wastewater utilities can market treated grey water themselves (urban greenery, agriculture) and will thus start tapping into the grey water market.

6.3 Outcomes of the Maximum Scenario

In the observed water use sectors the outcomes listed in tables 8–10 will occur (cf. also the explanations in the following chapter on impacts). Most of the presented outcome figures might be put as input when proving the (hitherto only roughly estimated) real water use in the basin with the help of the Water Management Tool.

Table 8: Outcome of the Maximum Scenario regarding residential water sector

	1385	**1404**
Population growth rate compared to 1385	100%	127%
Water prices	subsidized prices	cost covering energy prices + water supply fee
Resulting (inflation-adjusted) price of water compared to 1385	100%	170%
Reduction through the application of water-saving technologies [%]	0%	20%
Water losses combat strategy	none	optimum
Water losses [%]	25%	15%
Consumption of drinking water supply in the supported area [Mio. m³]	365	312
Drinking water consumption in the catchment area [Mio. m³]	300	257

Table 9: Outcome of the Maximum Scenario regarding agricultural sector

	1385	**1404**
Cultivated areas [ha]	250000	200000
Cultivation patterns	90% crops / vegetables 10% fruits	70% crops 20% vegetables / flowers (there off 15% greenhouses) 10 % Fruits
Water & energy prices	subsidized prices	cost covering energy prices + water supply fee
Irrigation strategy	based on sufficient amount of irrigation water	RDI*/PRD**/SDI***
Irrigation technology [ha]	Drip irrigation: 4,000 Sprinkler: 16,000	drip and surface irrigation: 40,000[6] sprinkler: 20,000
Observed agricultural water extraction [Mio. m³]	5100	2500
Real water use [Mio. m³]	2100	1600

* Regulated Deficit Irrigation
** Partial Root-Zone Drying
*** Sustainable Deficit Irrigation

6 The Agricultural Organization argued in its comment to the previous version of this report that such an increase in micro irrigation is not possible due to water and soil quality. Whereas drip irrigation is suitable not only for orchards, but also for greenhouses, underground irrigation (kuzeh systems and more advanced underground pipelines) allow also the irrigation of arable land. We suppose that about 10.000 ha arable land and crops like sugar-beet will be irrigated via micro systems.

Table 10: Outcome of the Maximum Scenario regarding industrial sector

	1385	1404
Industrial Growth	100%	200%
Water & energy prices	subsidized prices	cost covering energy prices +water supply fee
Saving technology	Minimum	New industries with saving technologies and endogenous regional development potentials In existing Industries: assembly and optimizing the waste water treatment plants and reuse the depolluted wastewater →Synergy in Eco-Industrial Parks
Industrial water consumption [Mio. m³]	150	max 300

Extremely comprehensive capacity development is required for the scenario to unfold its full potential. Appropriate measures should be very proactively identified and implemented in order to avoid obstacles that may otherwise hinder the success of the IWRM process. Temporal implementation problems should also be anticipated pro-actively in time, so that they can be countered by capacity development measures. Four different levels need to be addressed:

a. Round Table and people implementing the proposals for action/measures of the scenario
b. Training trainers (industry, agriculture – while bearing in mind the global state-of-the-art)
c. Training programmes for selected industrial and agricultural sectors[7]
d. Environmental education at all different levels of the education system

Water extraction fee

According to the current literature the introduction of a water extraction fee can be used for measures of the improvement and conservation of the water balance, as well as for the protection of the water bodies and nature conservation. Guiding idea for the water extraction fee is the waste water tax, for which there exist many positive experiences especially in the European Union (cf. Lorek 2004, ECOTEC 2001a,b). To promote the intented effects regarding agriculture, the collected revenue of the fee should explicitly be spent:

- for investigation costs of greenhouses as best appropriate water saving technology in the basin;
- for monetary compensation of impediments on agriculture in drinking water extraction areas or for cases in which a compulsory change in cultivation practices in these areas entails additional expenses;
- for the compensation of compulsory cultivation of riparian zones on agricultural land;
- for research on groundwater protecting agricultural practices in water reserves, drawing on model or pilot projects;
- supplementary consultancy for water pollution control which informs farmers about water protecting agricultural practices, including soil and water surveys;

In the residential area the water extraction fee is used for water-saving innovations.
On the other hand it must be mentioned that there is scepticism if the water extraction fee will work in the agricultural sector (cf. Molle 2008).

[7] The Agricultural Organization agrees in its comment to the previous version of this report that skilled agricultural man power as well as the development of the national and international markets are a big challenge to realize such a conversion of agriculture. The organizations doubts that it is possible to master this challenge.

Treaty between agriculture and industry

At the first meeting of the round table the representatives of agriculture and industry begin to realize that the regional water security is a risk that they share. Based on this assumption a regional treaty is sketched and written out. During the time of writing on both sides influential representatives develop a deep and friendly relationship, which lead to a mutual trust despite different mentalities.
The general idea of the treaty is reducing the shared water risks by combatting together the "closedness" of the water resource allocation. One of the focussed key actions is reducing the agricultural water demand, especially by reducing the total of the irrigated agricultivated areas. To compensate this considerable concession of the farmers industry will fill new jobs created with people coming from the agricultural sector. But that means that the round table is strengthening industry in such a way that a creation of new jobs come into view. Therefore it is necessary to bring industry in the area and to allow an increasing industrial water demand (as far as sustainable). Former farmers (now industrial workers and employees) are allowed to behave as part-time farmers with greenhouses (especially for their own use, including family and friends) when they abandon three quarter of their fields.
Settling in the eco-industrial fields allows those companies to regain globally competitiveness due to the materially and energetically efficient recoveries and other synergies in the parks The treaty between agriculture and industry includes payment of compensation to farmers who have to abandon farming and do not find new jobs (or are in the age of retirement),The state plays an important role in giving guarantees for the payment of compensations in the case that the industry has no opportunity to bring up the money needed for the compensations.

Greenhouse cultivation

Funded with financial resources collected by the water extraction fee in the basin all interested farmers are supported in converting to greenhouse cultivation. The Round Table is distributing the funds when farmers fulfil the following premises: They need to have testimonials of the successful participation in occupational training courses as well as a business plan for the next 10 years. Furtheron the farmers declare to use water efficient and regionally adopted greenhouse technologies and to abandon one third of their cultivation areas (which they might use for storage etc.).
If only because of the high daytime temperatures in summer and the relatively low night temperatures during the winter months, it will be vital to adapt the greenhouse technology to the conditions in the region. Corresponding research by the agricultural authority is to be intensified and carried out in public-private-partnerships with local industry, with reducing water use remaining an important developmental objective. Together with the agricultural authority the round table is working standards for adopted and water saving (closed) greenhouse technologies that can be used as a good orientation for the planning of the farmers ready to conversion.
By refining greenhouse technology, more and more water can be conserved and water productivity increased, as the production of tomatoes shows: In Spain, outdoor cultivation with drip irrigation still led to a consumption of 60 L per kg of tomatoes, unheated plastic greenhouses in Spain needed some 40 L*kg-1 (additional ventilation led to further savings of about 12 L*kg-1), an unheated glasshouse in the Middle East about 30 L*kg-1. A Dutch glasshouse with climate- and CO_2-regulation needed about 23 L*kg-1, reduced to only 15 L*kg-1 if the drainage water[8] was reused. In the Netherlands, a closed greenhouse with cooling ultimately required only 4 L*kg-1 (cf. Stanghellini 2011).
The expansion of the greenhouse acreage is controlled by the Round Table and the Institute of Spatial Planning which has yet to be established. In particular, care is taken that there are no problematic concentrations in some sub-regions, but that there is polycentric development in several sub-regions of the catchment area. This helps avoid unintentional mistakes and uncouples greenhouse cultivation from high water efficiency.
Care also needs to be taken that, with the help of monitoring by the environmental authority, promoting regional best practices in agriculture and sanctions if necessary, the increased amounts of fertiliser customary for greenhouse farming, compared to outdoor farming, don't place a strain on the environment (e.g. the groundwater). Technical measures like reusing drainage water can support this. With regard to pest management, care must

[8] Among experts, the reuse of drainage water is considered to be a sensible solution to the problem of salinisation, since otherwise aquifers would be contaminated by the seepage of this water with its salt load. During intensive horticulture, per year on average about 1000 kg of nitrogen, 1600 kg of chloride and 800 kg of sodium are flushed out of one hectare of land, which could contaminate over 100 million m^3 of groundwater. By recovering the water, up to 50% of the input of water and fertiliser can be saved (Kickler/Schramm 2014).

also be taken that there is support for biological and integrated pest management[9] as well as for strategies to minimise the use of chemical pesticides, and that these prevail. Especially in regions with small farms, weak management and unskilled workers, the challenge is that integrated practices require changes in educating farmers (e.g. strategic thinking). Thus consulting will initially focus on small units, where the owners also simultaneously represent the main labour force, and will drive expansion from there (Schramm/Kickler 2014). Separate collection systems for plastic and organic remains also need to be introduced, enabling the composting of organic remains without the plastic accrued in the greenhouse, so that the compost cannot only be used to improve the soil, but can also be marketed (Schramm/Kickler 2014).

If, supported by the pact with industry, the agricultural authority gives special attention to it, and workers' protection is also adequately taken into account, the expansion of greenhouses can benefit the poorest in the region, since it creates new opportunities for income through production, processing and trade. It enables broader and fairer economic growth in the catchment area and also contributes to fighting poverty (see Ali 2008). Where the farms are so large that additional manpower is needed, even impoverished rural residents with no own land can – provided the employment contracts are well designed – benefit from the transformation through permanent placement or temporary jobs (cf. Schramm/Kickler 2014; Weinberger and Genova 2005). Women who otherwise have only few alternative sources of income and no own land also benefit from the new jobs. If premium products are also exported and the relevant processing plants established in the region, it can be assumed that in the catchment area, mainly women will do the washing, cutting, labelling and bar-coding, which are all labour-intensive procedures (Dolan et al. 1999). Internationally, more women are employed in vegetable cultivation than in rice cultivation (Schramm/Kickler 2014).

Deficit irrigation

Reducing the applied water amount for irrigation and keeping the plants under a regulated water stress may lead not only to yield losses but also to an increase of the gross margins per applied water amount. If the application of water is more expensive (due to a water extraction fee or higher energy prizes) there is the opportunity for such strategies of regulated deficit irrigation (including partial root-zone drying and sustainable deficit irrigation). Farmers need to be adequately trained in order to implement such strategies. For pursuing such a strategy they must be supported with adopted irrigation scheduling plans or models. The generation of such specific irrigation scheduling strategies is commonly produced through simulation models which need to be calibrated or validated for the local conditions and plant varieties. These models must include appropriate yield-water functions or equivalents allowing to evaluate the yield impacts of water deficits (Pereira et al. 2002). They also need seeds and/or plants that have been adapted accordingly (e.g. drought-resistant varieties).

Better communication between farmers and the irrigation water supply management is also necessary so that water demand situations are managed in such a way that the plants and/or crops do not fail. Local agricultural water distribution systems also need to be improved and supplemented by temporary storage systems: To secure the intended deficit irrigation effects when supplied with surface water the farmers have to build and operate semicentral or decentral water tanks, small reservoirs or other water storages. The newly constructed storage systems serve as buffers, because it is likely that the central supply of irrigation water is delivered at a "wrong" time (e.g. to late, so that the plants are heavily affected or to early, so that it is not the time for a deficit irrigation but just a usual irrigation). The planning, construction, operation and maintainance of the buffers is a new task for the single farmers or the local communities.

Emergency plans

During this next dry period, it will be necessary to take a very clear stance in the IWRM process if scarcity situations occur again, despite the new transfers from the Karun region. Depending on the current consumption trends in the catchment area, the former prioritisation of industry over agriculture might possibly be abandoned, since most agricultural units make an important contribution to the welfare of the area, and not just the modernised farms that can be seen as being "industrialised". Due to the water extraction fee all user groups are also paying much more for water as they did in the past.

So the Round Table suggests that the Water Authority (together with Mirab and water & wastewater plants) develop a contingency plan to cut back on avoidable consumption. A state of emergency is proclaimed during dry periods (with a defined dam level) which puts in place measures ensuring a minimum of agricultural irriga-

9 In Jordan, the implementation of integrated pest management allowed reducing 60% of the pesticide application in greenhouses without causing a reduction in crop yields (Kickler/Schramm 2014).

tion: car washing is prohibited, parks are only irrigated with recycled water, there is a discontinuous water supply (2 hours twice daily) in the cities. A case is made for not just agriculture, but also the populace and manufacturing industry to adapt their own actions to it whenever possible.

Monitoring the quality of the groundwater by controlling inflow

It is necessary to develop and implement a legal framework and monitoring system (on February 20, 2013 in the meeting with water authorities and agriculture stakeholders in Isfahan Regional Water Company it was noted, that the use of pesticides and fertilisers has risen considerably in the catchment area.)

6.4 Impacts of the Maximum Scenario

Industry

Some of the stakeholders and decision makers participating in the scenario process are concerned about the possibility of the increasing water demand of industry.[10] Industrial corporations that like to settle in Isfahan bring in part there own employees into the region. So skilled workers are migrating into the area thus increasing the pressure on resources (residential water, energy production etc.). There is also some fear that further industrialization will lead to new environmental problems, especially air pollution and thus decling the environmental quality of the urbanized parts of the catchment area. But due to the scenario's restrictions and the introduction of spatial planning there is a great chance for a transformation towards an environmentally sound region. It is probable that not all of the water being allocated for the industrial sector will be needed. A big part of it will not be needed, so that it is serving as eco-water (recharge of aquifers, flow into Gaw Khuni and water for contract-agriculture maintaining certain ecosystem services).

Energy subsidies

The loss of energy subsidies might have political consequences because the farmers trust in the state is diminishing; it is a big challenge for the members of the parliament to explain the peasants that this strategy is necessary for the welfare of the whole nation and that the farmers are not the only group having now more expenses, but that the same is with industry. One fruitful explanation might be the Egyptian example where for years, the government has resisted cutting subsidies for fear of igniting inflation and the wrath of its citizens. In Egypt the energy subsidies are eating up 20 percent of its state budget and are likely to continue growing (Solovieva 2012). The country used to export gas but nowadays it is necessary for Egypt to import gas according to the growing demand due to minimal (subsidied) energy prizes. Another example might be the successful modernization of the agricultural sector in New Zealand after the end of subsidies (Ross/Edwards 2012).

Prizing agricultural water

The stepwise elimination of subsidies (for pumping energy) in combination with the water extraction fee makes in most cases water very expensive for industry and agriculture (except where Artesian wells are used). In principle a change in the production will be the result with a more rational water use, also in agriculture. But as mentioned before (in connection with the tradeable rights) metering is a necessary requirement for setting the amount and charging the water extraction fee, too. This is the fact for the use of groundwater wells as well as the use of surface water.

Trading of non-required water rights

Water trading is the process of buying and selling water access entitlements, also often called water rights. In certain parts of the region (especially in the eastern part of the basin) the water authority allows a temporary trading with itself as a regulating agency. One of the tasks will be to control the trading and to avoid misfeatures and undesirable developments (e.g. in other countries many local water resources have been acquired by Nestlé Waters and other firms, in order to provide commodity for the bottled water industry). A challenge for the regulator is the problem that at the moment there are more water rights than (balanced) groundwater yields so that a

[10] Especially the agricultural lobby emphasizes that the nearly doubled increase of industry water in the Maximum Scenario is contrary to the arguments brought forward in the discussions while scenario development. In their eyes an increase of the industrial water demand is no solution.

collapse of the market is possible. Determining price elasticity for the agricultural or industrial sector can be difficult as long as water use is not to be metered (and the metering controlled).

Irrigation technology

As in the Jointly Modified Outlook Scenario sprinkler irrigation was spread only during the first scenario years (between 1385 and 1390). It will not be pursued further due to the high evaporation losses and other negative experiences. In parts there will be even a quitting of sprinkler systems, in special in cultures where it is obvious that they are unsuitable or regarded as assets, having been amortized using the straight-line basis over their estimated useful economic life, not exceeding 15 years.
Except closed greenhouses drip irrigation will only be introduced in orchards because of the closed basin situation. As known from other regions, public subsidies to convert from flood to micro irrigation offset many of the negative impacts of drought on farm income. These subsidies also cause a reduction of the amount of water applied to crops and in some cases led to rising value of food production (e.g. when improving the farm's water security), but can increase crop water depletions (Ward 2014).

Livestock

In some areas like Nekuabad the reduction of cultivated area affects animal breeding. Either a reduction of livestock is necessary or a transfer of manure or slurry to other regions where forage maize and other fodder will be produced in future. A third possibility is the treatment of manure/slurry in biogas plants.

Ecosystem services

Rivers in their natural state provide many human valued ecosystem services that make them an important environmental resource. Wetlands provide a wide and diverse range of environmental services including habitat for endangered species, flood protection, water purification, amenities and recreational opportunities. Ecosystem degradation and the loss of biodiversity undermine ecosystem functioning and resilience and thus threaten the ability of ecosystems to continuously supply the flow of ecosystem services for present and future generations. Ecosystem services can be categorized into four types (Nikouei et al. 2012, Gilvear et al. 2013 and Comino et al. 2014):

- Provisioning: food (crops & livestock products); biomass (fibre & energy materials); water for use (supply, irrigation, cooling etc); and health products,
- Regulating (carbon regulation; water flow & flood regulation; water quality regulation; human health regulation)
- Supporting (biodiversity; soil formation; nutrient recycling)
- Cultural (science & education; tourism & recreation; esthetics, socio-cultural practices).

The Gavkhuni wetland plays important hydrological, biological and ecological role in the natural functioning of the Zayandeh Rud basin. It was/is also an important wintering area for a variety of waterfowl, surface feeding ducks and some shorebirds and hosts a large number of migratory birds during winter. The future of water allocated for the protection and security of wetlands depend on economic, social, and political development trends and the results of litigation, legislative, and administrative debates (Nikouei et al. 2012).
The ecosystem services rendered by agriculture are not only depending on the farmers' knowledge about these relations as well as on labour, machinery and capital, but also on an adequate supply of water. Until now this contribution of agriculture to environmental protection in the area was not addressed in the debate about the solution of the water distribution conflict in the catchment area. Due to the conversion on parts of the arable land to horticulture a part of the agricultural area is given up and thus threatened by desertification. But at least the glasshouse and/or plastic desert created in the modernificaton process is less of a target for wind erosion, as opposed to a sandy desert. The open question is what will happen if a lot of smallholders that do not have the capital for such a conversion give up their agricultural activities due to the water insecurity in the catchment area. In case that there is a reduction of agricultural area large parts of it will no longer be covered by plants and thus the wind may cause erosion and dust pollution.
As far as the farmers are behaving strictly economically they will give up first marginized areas that are in the eastern part of the basin. To maintain the ecosystem services of this area certain forms of land management are necessary. Therefore for some parts of the eastern region a contract agriculture needs to be introduced with an attractive payment for the cultivation of autumn crops to protect the environment. The introduction of a social-ecological regulation will improve that approach (see Kluge, Liehr, Schramm 2008): Farmers will be paid for producing certain ecosystem services.

7 Comparative evaluation of scenarios

7.1 Results of the Trend Scenario

Distinctions can be made between years with large or sufficient amounts of available water and those with insufficient amounts, in principle it cannot be ruled out that – among other things due to global climate change – there will again be several drought years in succession. According to the relatively high water consumption, the catchment area will then have no water security, even if more water is transferred from the Karun catchment area into the basin. It is very likely that in future there will be more resistance to those plans.
In consequence in the Trend Scenario, Isfahan will lose its significance for investors due to ongoing increased water stress. At the same time, the lack of tourists can be expected to lead to losses for all hotels, pubs, shops, restaurants and other facilities. Overall, if this trend continues, there will be negative economic consequences for the city of Isfahan and the catchment area.
Plans are in place to allocate additional water in the industrial sector, but this allocation is controversial. There will be a problem of acceptance with regard to public water allocation. Increased vulnerability of farmers to the increase, frequency and intensity of droughts and other extreme events and the corresponding economic losses could lead to social unrest among the rural population. In any case, the conflicts between the agricultural sector and the Water Authority will be exacerbated.
In drought years, the Zayandeh Rud will remain dry during almost the whole year, as before. This will impact not only tourism, but also the self-image of the population: Isfahan will no longer be a prosperous oasis. In the Trend Scenario, society will still remain vulnerable to water stress. Therefore, there will be further conflict over the allocation of the insufficient quantity and quality of water; this will also impact the economy.
This will make the catchment area unattractive for many investors, just as the deteriorating environmental conditions will. The lack of water security will become a shared risk for all water users. Those industries that are water intensive and/or for whom water is a vital production factor will attempt to avoid this risk. To this end, they will look for other catchment areas where water safety is not under threat. The industries still remaining in the catchment area will try to adapt their production to the given situation. Both strategies mean that, when it comes to water scarcity in the catchment area, there will be no positive economic consequences for the industrial sector*. So despite a clear privileging of industry, a lack of water security for all user groups thus makes the entire economy vulnerable.
If the agricultural use of water continues as it previously has, the utilised groundwater in particular will sink further, due to excessive abstraction with deep wells. This will lead to more groundwater being pumped from deeper, more saline layers, which will cause problems for the soil and crops. So the quantity of agricultural crops produced in the catchment area will continue to decline. In order to cope with food shortages in the region, the government will import many agricultural products from other regions and even from abroad. In the Trend Scenario, insufficient amounts of water for traditional crop cultivation on the one hand, and the non-paid compensations by the government and insurance companies on the other hand, as well as potentially higher production prices compared with imported products, will have an extremely negative economic impact on the agricultural sector. Since industrialised farms, whose water supply is privileged during droughts, are treated differently, there will be further severe tensions between traditional and modernised farms.
If, as has previously been the case, the price of water in the Trend Scenario is subsidised by the state, no positive economic impact on urban water management can be expected. Due to the water sector's economic dependence on the central government and lack of funds, plans for development and improvement will not all be implementable.

7.2 Results of the Jointly Modified Outlook Plan Scenario

In this scenario, plans for future development which have been jointly agreed upon and which concern the water demand between the different sectors in the catchment area, can help safeguard their economic situation. At annual meetings between the representatives of the various different sectors, measures for distributing water during dry periods or crisis situations will also be identified. Thanks to these joint discussions, established industries will recognise the need for production-integrated environmental protection (and will be able to make the necessary investments with the help of government funding measures). However, industries newly establishing themselves in the catchment area will only sporadically be willing to transition to efficient water use and/or

production-integrated environmental protection. The investments will pay off for the industrial sector, leading to the assumption that in regard to water this scenario will also have no negative economic effects on industry in the long term. Numerous new companies will establish themselves.
Getting the provinces to cooperate currently seems to be difficult to achieve, as the comments made by Mr. Zagar during the meeting on October 29th 2013 also made clear. Differently to the Maximum Scenario a deficient cooperation with Chaharmahal ye Bakhtiary does not restrict the implementation of most measures of the Jointly Modified Outlook Scenario in the main part of the basin, belonging to the province of Esfahan.
In the Jointly Modified Outlook Scenario, the agricultural sector will recognise the water scarcity problem in the catchment area and make preparations to use water resources more wisely with the help of an adjustment programme. However, due to funding constraints, only a small proportion of farms will be able to take advantage of this programme. By planting products with higher profit margins, such as different kinds of vegetables, the respective farmers will be able to achieve economic security for the first time. Drip irrigation systems will be introduced only where fruit is grown. But over time, even the farmers will increasingly consider investments in fruit-growing to be problematic, since no water security can be achieved in the region. If potentially there is no irrigation water during dry periods, trees might die, thus destroying their capital. So the acreage with orchards will stagnate at the level of 1385.
In the Jointly Modified Outlook Scenario, during the next dry period (e.g. from 1398 onwards) the drought emergency plan newly developed by the Water Authority (together with Mirab and the water- & wastewater sector) will be presented and discussed at the annual meeting of the sectors in the catchment area of the province. A state of emergency will be proclaimed during dry periods (with a defined dam level) which puts in place measures ensuring a minimum of agricultural irrigation: car washing is prohibited, parks are only irrigated with recycled water, there is a discontinuous water supply (2 hours twice daily) in the cities. A case is made for not just agriculture, but also the populace and manufacturing industry to adapt their own actions to it whenever possible.
In the Jointly Modified Outlook Scenario, the water companies will have more income due to higher water prices, thus covering operational costs.
The collaboration between the environmental and water authorities will lead to joint monitoring of the quality of surface water and thus to discussions about the state of the Zayandeh Rud. The results of the monitoring will also be featured in the press once in a while, but will not lead to a significant change in environmental awareness in the catchment area. Furthermore, industrial wastewater and, via so-called spray liquids, agricultural pesticides will be funnelled directly into the aquatic environment. Earlier or later the salt lake Gavkhouni will permanently dry up.
The rapid rate of desertification and wind erosion in the catchment area will lead to an increased dust load, so that air quality will deteriorate. Like in Hormozgan and Ilam, the city administration will decide several times that schools, universities and government offices remain closed due to heavy air pollution.
There will be a rapid deterioration in the quality of surface- and groundwater. The groundwater is contaminated with pollutants, and the pollutants in agricultural crops will increase significantly (e.g. heavy metals and pesticides). The salt lake Gavkhouni will permanently dry up.
Environmental problems (such as poor air quality near established industries and airborne dust particles) will lead to cancer and other diseases in the urbanised parts of the catchment area, especially if there will be a future settlement of heavy industry. Air quality will also deteriorate due to the rapid rate of desertification and wind erosion in the catchment area (the problem of dust particles, as currently present in many cities such as Hormozgan and Ilam). The city administration repeatedly closes schools, universities, and government offices because of excessive air pollution. Due to environmental diseases, the disease rates will increase. Due to these reasons parts of the population of the catchment area feel increasingly insecure and consider to migrate into regions with higher security.
Towards the end of the observation period it will become clear that the mutual goal which industry and agriculture had struggled to come to a consensus upon in this scenario (zero growth in water demand) will not be attainable, because many industrial companies are newly establishing themselves and agricultural modernisations are only slowly being implemented. As a result, there will be renewed conflict between industry and agriculture which will lead to the talks between the sectors being cancelled and the IWRM process being declared a failure in 1404.

7.3 Results of the Maximum Scenario

Getting the provinces to cooperate currently seems to be difficult to achieve, as Mr. Zagar clarified in his statement during the meeting on October 29th 2013. In difference to the Jointly Modified Oultook scenario a deficient cooperation with Chaharmahal ye Bakhtiary devitalises the implementation of some measures of the Maximum Scenario in the beginning. Especially there is the risk that in the beginning the agricultural sector in the province of Esfahan is alluding to the water allocation practice in the neighbouring province. But also there the higher energy prizes are leading to a reduction of the extraction from Zayandeh Rud.

In the Maximum Scenario, industrial growth in the catchment area will intensify not only because new industries (only with water-saving technologies) with endogenous regional potential will establish themselves, but also because wastewater treatment plants will be built (also at indirect dischargers in problematic sectors) and industrial wastewater treatment plants will be optimised. Because the established industries start reusing treated wastewater, their water security will also improve. Both trends will lead to the creation of new jobs on a large scale. The process will improve the chances for sustainable growth and ultimately have a positive economic impact on the region.

In the Maximum Scenario, lectures will attempt to educate farmers that the value of a product and the amount of water needed to produce it should be linked. As a result, the agricultural sector (with regard to its acreage) will reduce the production of water-intensive crops such as alfalfa or clover, which are of little economic importance to farmers.

Promoting greenhouse cultivation will make the structural change economically interesting for farmers in the catchment area. Through funding programmes for greenhouse cultivation, which also function without farmers having to invest their equity, the production of products with higher economic value, especially vegetables, will develop further. However, it will not be possible to convince all farmers. Where traditional farmers continue to cultivate farmland, they will bank on organic farming, since this is an area in which viable sales channels already exist (see below). It will become clear that, in order to curb wind erosion, the use of agricultural land cannot be completely abandoned. Farmers that counteract desertification by preserving the vegetation cover while using little water will receive agricultural subsidies.

In an industry-initiated pact with agriculture, farmers who give up farming because of increased water and energy costs are taken on as industrial workers. If they want to, they can set up a small greenhouse for their own consumption while receiving all the water they need.

In the Maximum Scenario, organic farming might develop and ecotourism in rural areas might be promoted, so farmers will be able to enhance their income through ecotourism/agritourism and options such as carpet-weaving workshops for tourists.

This will give farmers economic security for the first time and reduce the total water consumption of the sector. Because of higher water prices, many investments for building greenhouses or new irrigation technologies will be planned and carried out till 1404. Despite the reduced acreage and high investment costs in the agricultural sector, this scenario will be sustainable overall and have a positive economic impact on farmers.

In those areas in which a regulated deficit irrigation system is established, the local irrigation water distribution systems will be improved and supplemented by temporary water reservoirs. This will have positive results on the development of a participatory irrigation management, which might have some features of a self-organization.

The quality of agricultural crops will improve and consequently there will be a focus on the cultivation of premium products (because of increased production costs due to rising water and energy prices, it's not worth producing low-quality products that are cheap to sell). In order to market premium products, a food industry needs to be established to process the products, such as producing and exporting dried fruits, canned goods, and even precleaned and ready-to-cook vegetables and meat for the international market.

In the Maximum Scenario, changing water-consciousness due to increased prices, combined with awareness campaigns and environmental education to create a sense of responsibility for nature and the environment in society, will lead to significant water-savings in households. Supported by foundations, mosques, schools and sports clubs will also become involved in reducing water consumption. Thanks to funding through fees and subsidies funded by the water withdrawal fee, the water companies will carry out improvement projects and measures for renovating the water supply networks as well as raise the quality of drinking water and wastewater treatment. Until 1404, consumers' expectations will rise to meet the quality of services, since they will be paying more for them and, on the other hand, are learning more about deviations from the goal and good ecological management via environmental education and the media.

Many new jobs will be created, especially in the industrial sector. New jobs in the service sector will be created and there will be secure investments in various areas (due to increased numbers of tourists). Agritourism and

production of handicrafts as additional sources of income will also increase the satisfaction of the protagonists in rural areas.
More environmental education and the resulting changes in environmental awareness will lead to active participation and collaboration, for example between agriculture and the environmental authority. This and the partial switch to organic farming and/or integrated crop production will lead to a reduction in the seepage of pollutants into the groundwater and into the runoff which flows back into rivers.
The intensified cooperation between the environmental authority and the water authority will lead to an optimised quality of the river. Just like in the Jointly Modified Outlook Scenario, the quality of the ground- and surface water will be monitored by controlling the inflow of pollutants. However, by creating and implementing the legal framework, it will be possible not only to establish a monitoring system, but also to penalise excessive pollutant discharges when necessary. Accordingly, industry will monitor exhaust fumes and wastewater together with the environmental authority.
In contrast to the two other scenarios the inflow of water into Gavkhouni is guaranteed and its ecosystem services are secured. The wetlands and other natural ecosystems will recover in the long term as well as the aquifers.

7.4 Comparison

The following table 11 summarises the results of our impact assessment of the three scenarios. In the main scope of the assessment had been results caused by changed water management. For simplification purposes other effective causes such as international political or economic influences have not been taken into account, but will be equally effective.

Table 11: Summary of results as worked out in the impact assessments of scenarios

		Trend Scenario	**Jointly Modified Outlook Plan Scenario**	**Maximum Scenario**
Economic results	Industry	**- 0**	**0 +**	+
	Agriculture	**-**	**0 +**	+
	Residential water management	**- 0**	**0 +**	+
	Isfahan City	**-**	**0 +**	+
	Gavkhouni	**-**	**0 +**	+
Social results	Industry	**- 0**	**0**	+
	Agriculture	**-**	**0 +**	+
	Isfahan City	**-**	+	+
Environmental results	Catchment area (incl. Isfahan City and Gavkhuni)	**-**	**0 +**	+

Validation	Meaning
+	Positive impact for sustainable development
0 +	Non or small positive impact
- 0	Non or small negative impact
-	Negative impact

8 First results of the scenario transfer

Some preliminary results of the scenarios have been presented to the decision makers and stakeholder in the province Isfahan. Mr. Zagar, the governor of the province Isfahan, critically questioned the treatment of institutions in the scenarios. In our experience it is quite obvious that there will be a transition of the institutions during the IWRM process. It would be interesting working out the changed institutions and the ways how to transform the institutions planfully. This task was not part of our work hithertoo.

Isfahan Regional Water Company, the Agricultural Organization of Isfahan province and a round of experts had the opportunity of reading a previous version of this report. This process allowed an early beginning of a transfer of the scenarios.

The Agricultural Organization of the province discussed intensively the scenarios. Their experts came to the following conclusions:

- "Escalation in agriculture water productivity in the Zayandeh Rud basin, calls for shifting from traditional agriculture towards modern and industrialized farming, which could be attained by establishment of large multipurpose agriculture farms and agro-industry near large farming lands and food processing plants to address unemployment of youth and small holders.
- The role of agriculture organization in optimization of water consumption should be considered.
- For water productivity, integrated water resources management in the Zayandeh Rud from upstream to downstream under one management should be established.
- Construction and fixing of entrance points and flow devices at the intake of traditional networks, along with monitoring and installing intelligent volumetric counters for marginal agricultural wells and to regulate water abstractions.
- Planning and implementation of water volumetric delivery in the networks in terms of time and location.
- Increase of investments (public & private) in agriculture in order to escalate water applicability and optimization.
- Regarding high costs of urban and rural treated water supply and incremental growth of consumption and its overall effects on agriculture sector, utilization of intelligent facets in order to controlling water of households, in urban, rural, institutions and industry is indispensable.
- Due to closeness in water resources of the Zayandeh Rud, extension of urbanization and industry should be limited: Surveillance and precision control on water extraction from the Zayandeh Rud water resources (in four sectors of: urban, industry landscaping and agriculture) in order to restore equilibrium to the basin and the river.
- Closing of all illegal water wells especially in the river marginal bands.
- Harmonization among the water allocations granted by Energy ministry and the social-natural conditions of the studies in the Zayandeh Rud basin and necessity of due attention in this relation and even obliteration of some allocations in upstream part.
- Management of water and supply system and heightening irrigation efficiency and production performance especially in peak water needs.
- Plantation of rice in Nekouabad left and right networks should be reduced to half of its current farming extension in a twenty year outlook in 5 year steps, and to extend green houses and other agricultural produce. Meanwhile, the losses to rice farmers should be remunerated by government and new tariffs for water in agriculture enacted.
- In order to introduce strategic productions (crops) with low water demand, a joint committee comprised of IRWB, Agriculture Organization, Agriculture Research Center and University should be formed to pave ground for higher water productivity. In this regard, the guaranteed purchase price of certain agricultural produce should be revised and promotion to stake holders towards integration and utilization of modern irrigation networks in strategic cultures (including Roudashtein), be granted.
- There has been no reference to water needs of some agricultural productions throughout the year, while for the downstream part of Isfahan, irrigation is allocated to certain months from the river and for the rest of the months, there is no water right. Thus, it seems that irrigation strategy should be modified and substituted by a new plan.
- Payment of compensation to the farmers who have to abandon farming, by means of increase in water tariff, has been proposed. Due to extension of the area and inability of other sectors with regards to higher water tariffs, how is this possible? If this compensation cannot be paid what other options are practicable?"

After the discussion of the previous scenario report the perception of the endogenous development of the catchment changed. During a meeting in February 2014 to which the governor of the Isfahan province invited most key stakeholders the assembly came to the conclusion that the carrying capacity of the Zayandeh Rud catchment does not allow much industrial growing.

Some parties had the proposal, that it would be better having scenarios starting from "wet years" or from "dry years;" therefore it was also suggested to multiply the number of scenarios from 3 to 9 with regard to certain meteorological conditions (influencing agricultural practice). The realization of such an idea affords not only more financial resources as the fund of the German ministry of research. It would be more adequate for natural science scenarios combined with simulations. We have to keep in mind that those ideas are not very realistic for a project following the scenario planning approach. In the scenario planning process the aim is not to take decisions from the effects of the scenarios only but to gain deeper insights regarding the future dynamics and to improve strategic thinking. In the German-Iranian project "IWRM in Isfahan" the scenario approach is distinguished from the simulation approach that is associated with the Water Management Tool. With the help of the Water Management Tool it will be possible to illustrate the three scenarios for different weather conditions. Such different simulations based on different scenarios and its study can be executed by the experts of the Isfahan Regional Water Company in future.

9 Recommendations

In reality, it will not be possible to implement the above-described scenarios in the catchment area as they have been described by us, for several reasons:

Firstly, apart from the fact that the scenarios should not regarded as scientific proposals how to shape the future, it will be difficult to reach all the protagonists with economic measures , which play a significant role in the Outlook and the Maximum Scenario. At least it is not possible to reach the different protagonist to a similar degree. The protagonists are living under very different conditions, thus making very unequal factor prices a prerequisite for them to be able to behave in an economically rational manner. Especially in agriculture, the water in the catchment area is the central factor of production; it is indispensable in agriculture without under any circumstances. However, as long as the state fixes the prices for crops, the extent to which farmers can act rationally is very limited, since it is unclear to what extent they can pass on their increased production costs in the value chain.

Secondly, the agricultural sector in particular is not yet prepared for the commodification of water, especially since up till now there has been no way of objectively measuring the amount of water used for irrigation. Without this kind of valuation (e.g. through compulsory water metres or other means) it will be impossible to create the conditions for the introduction of prices "that tell the truth".

Thirdly, in the real world an IWRM process almost always requires that the institutions themselves also change. Therefore it needs to be asked whether this should also be the case in Isfahan. Mr. Zagar has already raised this question. He also pointed out that at the moment it seems to be difficult to implement a collaboration between the provinces – as was a prerequisite for both scenarios except for the Trend Scenario. Currently, the two provinces want to have nothing to do with each other with regard to sustainable water distribution in the catchment area. The representatives of both provinces don't even like to attend meetings together. So the question arises: How can one speak of collaboration? What should it actually look like? Is it really necessary? At this point it becomes clear that the scenarios have been designed as ideals. They are supposed to show that change is possible and that for the protagonists in the catchment area, there are numerous opportunities to act together. However, the scenarios are not a blueprint and cannot be implemented one-to-one, especially since some requirements will change in the future (Molle 2008). The (for example in the Maximum Scenario rather radical) measures that need to be taken will also not be realisable and implementable within ten years in such a manner that the expected effects unfold. Therefore it would be necessary to define an appropriate framework of action for the IWRM and adapt the scenarios to it and/or extract from them aspects that are easy to implement and see whether the IWRM-process as a whole can work that way.

We would like to return to Mr. Zagar's comments again. Ultimately, the IWRM is a regional grouping of different protagonists that creates a new (and institutional) constellation between different levels and structures (organisations, laws and rules) with the aim of achieving an optimised water use in all sectors by understanding the regional relationship between

- surface and groundwater as well as their interactions
- soil and water (resources) and
- water and the environment.

So that this process unfolds in a sustainable manner, aspects of

- economic efficiency and
- justice need to be sufficiently taken into account.

So the responsible protagonists in the catchment area of the Zayandeh Rud should, based on the German-Iranian "IWRM in Isfahan" project, define a structure with which they will clarify paths of communication and guidelines for cooperation (or at least define its rules). Based on this, the results presented here can be used to develop a new management approach. At the moment it is not quite clear if it is possible to use for a plausibilisation the Water Management Tool with regard to their water management effects.

Beyond the level of the catchment area, it might be useful to think about reforming water legislation. Similar to German law, it might make sense to move away from the existing water rights which the state grants a company or operator in permanence. Given changing conditions and excessive water extraction, the conversion of these "eternal" water rights into two legal forms could make the current rigid water rights (especially with regard to groundwater) more flexible: a water extraction permit for industry and agriculture (valid for about 10 years, can be revoked), and/or a water permit just for extracting drinking water (valid for 30 years, with a secure legal position).

However, a longer time period than ten years is needed for this kind of reform by Parliament and the subsequent adaptation of water rights in the region. Incidentally, with the help of these kinds of permits and authorisations it will also become possible to make water extraction dependent on how high the level of an aquifer or a river is.

An important prerequisite for solving the enormous water allocation problem is a shared problem view of key stakeholders of a possible IWRM process in the basin. For a shared problem vision it is not enough when all the shareholders agree that there is no water security in the catchment area; an awareness of the closed situation of water resources is necessary, containing sufficient water amounts for the nature providing all the ecosystem services the peoples' welfare is relying on.

As basin water resources become tighter, there is a need for better accounting of water flows and a better understanding of the complex flow network that develops. The Water Management Tool allows a development of the before mentioned better understanding but the scientific basis especially regarding (hydro)geological surveys is very limited and should be improved. Also adequate water accounting is essential to backup negotiations; especially the date base for the agricultural groundwater use in to be improved immediately because it is the most important stream in the basin.

Capacity development is needed to allow potential investors in the different sectors to act in an adequate manner.

Ecosystem conservation and land use management are strong needs supporting the decision-making process. A good IWRM process needs an institution covering not only the water management, but also the other resorts.

Water metering is necessary not only for a better data base (modelling), but also to implement (economic) measures for reducing the applied water amounts (especially in agriculture).

There is need to come to an improvement of the different water supply systems and especially of the irrigation supply systems in the catchment area. Not only water loss reduction but also a transformation towards a more resilient supply system (with local buffer reservoirs allowing a participal irrigation management) would induces more efficient water use and a more flexible production. Therefore one central goal should be "re-establishing the environmental balance in the use of the natural resources" (cf. Pereira et al. 2002).

Better crop patterns of the farmers heavily rely not only on recommendations of drought resistent varieties of culturized crop plants by the National Gene Bank or other competent agro biodiversity experts, but also on the possibility of buying such seed.

The possibility of using (fossil) groundwater gives the Isfahan water authority some years for the decission of how to act in the future and how to build up a sustainable process for an integrated water resource managment. But the use of such (no regenerating) groundwater is not sustainable and its use is only possible for some years (cf. Polak/Klingbeil/Struckmeier 2007).

Neither capital nor land or work but water is the most limiting resource for the sustainable development of the Zayandeh Rud basin. In literature it is recommended that "under such conditions maximising the return per unit of water may be more profitable than the return of per unit of land." (Pereira et al 2002) A future IWRM proces in the region should therefore allow improving the perception of the water's value for society as well as for nature (Gavkhuni, regeneration of groundwater, avoiding desertification).

Environmental education is a measure to improve all users' awareness on the implications of water scarcity and to develop a common understanding of the basin's main problem to be solved in the future: Using the given water resources in a way that there is enough water for all the sectors and also for the ecoystem services of the catchment area. On the other hand it is necessary having the users' preparedness for their participation in water resources managment on all levels (up to the single farms and households). Such an environmental education might start now; there is no need to wait until the decision makers come to their decisions on wise ways of an IWRM process and its direction. The enviromental NGOs in the region might support the educational system in such educational processes.

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Appendix

Conducted meetings and list of participants

17-18.09.2012	Scenario/main module preparation workshop, Petersberg-Almendorf
DHI-WASY	Michael Kaltofen, Sebastian Sklorz, Rolf Timmermann
inter 3	Shahrooz Mohajeri, Tamara Nuñez, Wolf Raber, Sharare Ghanavizichian, Sonja Taheri
ISOE	Engelbert Schramm, Elnaz Sattary, Jörg Felmeden, Arash Davoudi
p2m	Jens Haberkamp,
IEEM	Andreas Kluska
08.11.2012	Presentation of first scenario ideas to Iranian project partners, Berlin
ESRW	Mr. Torfeh
EWWC	Mr. Amini
Inter 3	Shahrooz Mohajeri, Tamara Nuñez, Wolf Raber
ISOE	Engelbert Schramm, Elnaz Sattary
16.02.2013	Joint discussion between members of the IWRM commission and German team, Isfahan
ESRW	Mr. Asady, Mr. Aghili,
Inter 3	Shahrooz Mohajeri, Sharare Ghanavizichian
ISOE	Engelbert Schramm, Elnaz Sattary, Arash Davoudi
Regional experts	Mr. Ziayi (Zayandab Consultant: Manager of irrigation networks and water transmission lines)
17.02.2013	Workshop to develop the Jointly Modified Outlook Scenario, Isfahan
	Mr. Torfeh (chairman of the board of directors and managing director of ESRW)
	Mr. Aslani (deputy of planning and management of ESRW)
	Mr. Asady (ESRW)
	Mr. Heidarpour (operation and protection deputy of ESRW)
	Mr. Mousavi (development and plan deputy of ESRW)
	Mr. Karamalian (basic studies deputy of ESRW)
	Mr. Taghian (legal advisor of ESRW)
	Mr. Aghili (ESRW)
	Mr. Ghobadian (operational deputy of EWWC)
ESRW	Shahrooz Mohajeri, Sharare Ghanavizichian
	Engelbert Schramm, Elnaz Sattary, Arash Davoudi
	Mr. Rafiee (supervising expert of governar´s office)
	Mr. Ranjbar (urban services deputy of municipality)
	Mr. Hajian (manager of Mirab water distributing company)
	Mr. Kalantari (managing director of environment organization)
	Mr. Safavi (head of civil engineering faculty in university of Isfahan)
	Mr. Ziayi (Zayandab Consultant: Manager of irrigation networks)
	Mr. Nikouei (agricultural research center)
EWWC	Mr. Kermani (agricultural produce deputy)
Inter 3	Mr. Mamanpoush (expert of agriculture research center of Isfahan)
ISOE	Mr. Sarafrazi (Water and soil department manager of MAJ)
Regional experts	Mr. Samimi (general manager of Shahr & Khaneh consultant)
	Mr. Esmayili (Zobahan water supply manager)
	Mr. Tavakkoli (industrial towns' deputy)
	Mr. Nikneshan (mines and industries expert)
	Mr. Chavoushi (general manager of National Iranian Oil Products Distribution Company)
	Mr. Nili (energy and fluids manager of steel company)
	Mr. Esmaeilzadeh (design and planning manager of poly acryl Company)
	Mr. Momtazpour (manager of central plateau & Kashan water transfer transmission)
	Mr. Dallalzadeh (general manager of Aab-Pouyesh-Bana consultant)

19.02.2013	Workshop to develop the Maximum Scenario, Isfahan
	Mr. Aslani (deputy of planning and management of ESRW)
	Mr. Asady (ESRW)
	Mr. Heidarpour (operation and protection deputy of ESRW)
	Mr. Aghili (ESRW)
	Mr. Ghobadian (operational deputy of EWWC)
	Shahrooz Mohajeri, Sharare Ghanavizichian
ESRW	Engelbert Schramm, Elnaz Sattary, Arash Davoudi
	Mr. Rafiee (supervising expert of governar´s office)
	Mr. Safavi (head of civil engineering faculty in university of Isfahan)
	Mr. Khan Ahmadi (head of agriculture research center)
EWWC	Mr. Ranjbar (urban services deputy of municipality)
Inter 3	Mr. Samimi (general manager of Shahr & Khaneh consultant)
ISOE	Ms. Ahmadi (I.U.T. assistant professor)
Regional experts	Mr. Yazdabad (Padidab consultant)
	Mr. Nikouei (agricultural research center)
	Mr. Ziayi (Zayandab Consultant: Manager of irrigation networks)
	Mr. Shirzadinezhad (general governor's office expert)
	Mr. Sarafrazi (Water and soil department manager of MAJ)
	Mr. Momtazpour (manager of central plateau & Kashan water transfer transmission)
	Mr. Kermani (agricultural produce deputy)
	Mr. Dallalzadeh (general manager of Aab-Pouyesh-Bana; consultant)
20.02.2013	Discussion with water authorities and agriculture stakeholders, Isfahan
	Mr. Aslani (deputy of planning and management of ESRW)
ESRW	Mr. Asady (ESRW)
	Mr. Heidarpour (operation and protection deputy of ESRW)
	Mr. Aghili (ESRW)
Inter 3	Shahrooz Mohajeri, Sharare Ghanavizichian
ISOE	Engelbert Schramm, Elnaz Sattary, Arash Davoudi
Agriculture stake-	Mr. Kermani (agricultural produce deputy, Agricultural Organization)
holders	Mr. Nikouei (Agricultural Research Center)
	Mr. Sarafrazi (Water and soil department manager of MAJ)
	Mr. Ziayi (Zayandab Consultant: Manager of irrigation networks)
16.07.2013	Joint discussion about scenarios with Iranian Partners, Berlin
Iranian Partners	Mr. Aslani (deputy of planning and management of ESRW)
	Mr. Asady (ESRW)
	Mr. Ziayi (Zayandab Consultant: Manager of irrigation networks)
	Mr. Safavi (head of civil engineering faculty, University of Isfahan)
	Mr. Kazemi (ESRW)
Inter 3	Shahrooz Mohajeri, Sharare Ghanavizichian
ISOE	Engelbert Schramm
27.09.2013	Presentation and discussion about agricultural scenarios with Agriculture stakeholders, Frankfurt am Main
Iranian Partners	Mr. Kermani (agricultural produce deputy of Agricultural Organization)
	Mr. Sarafrazi (Water and soil department manager of MAJ)
	Mr. Nikouei (agricultural research center)
	Mr. Abdar (deputy of planning and management optimization of ESRW)
Inter 3	Shahrooz Mohajeri
ISOE	Engelbert Schramm, Elnaz Sattary
26-28.10.2013	Presentation and discussion of modified scenarios with Esfahan water authorities
ESRW	Mr. Torfeh (chairman of the board of directors and managing director of ESRW)
	Mr. Aslani (deputy of planning and management of ESRW)
	Mr. Kazemi (ESRW)
	Mr. Rajabi (ESRW)
	Mr. Asady (ESRW)
	Mr. Aghili (ESRW)
	Mr. Kazemi (ESRW)

	Mr. Ziayi (Zayandab Consultant: Manager of irrigation networks)
Iranian Partners	Mr. Safavi (head of civil engineering faculty, University of Isfahan)
	Mrs. Faramarzi (University of Isfahan)
	Michael Kaltofen, Sebastian Sklorz
DHI-WASY	Shahrooz Mohajeri
Inter 3	Engelbert Schramm, Elnaz Sattary
ISOE	
29.10.2013	
Governor’s office	
Energy Ministry	Mr. Zargar (Governor of Isfahan, water expert)
	Mr. Jangi
ESRW	Mr. Ehsani
	Mr. Torfeh (chairman of the board of directors and managing director of ESRW)
	Mr. Aslani (deputy of planning and management of ESRW)
	Mr. Ghobadian (operational deputy of EWWC)
	Mr. Heidarpour (operation and protection deputy of ESRW)
	Mr. Abdar (deputy of planning and management optimization of ESRW)
	Mr. Karamalian (basic studies deputy of ESRW)
	Mr. Momtazpour (manager of central plateau & Kashan water transfer transmission)
	Mr. Dorri (ESRW)
	Mr. Kazemi (ESRW)
	Mr. Zahab-Zeyghi (deputy of environment of ESRW)
	Mr. Asady (ESRW)
	Mr. Aghili (ESRW)
	Mr. Sahbayi
EWWC	Mr. Ziayi (Zayandab Consultant: Manager of irrigation networks)
Iranian Partners	Mr. Safavi (head of civil engineering faculty in university of Isfahan)
	Ms. Faramarzi (University of Isfahan)
	Mr. Nasr Deputy Manager of Plant production of MAJ)
	Mr. Kermani (agricultural produce deputy, Agricultural Organization)
	Mr. Sarafrazi (Water and soil department manager of MAJ)
	Mr. Nikouei (Agricultural Research Center Isfahan)
	Ms. Safigholi (department of environment)
	Mr. Soleymani (Zayandab Consultant)
	Mr. Raghibi (University of Isfahan)
	Mr. Sajjadi (University of Isfahan)
	Michael Kaltofen, Sebastian Sklorz
DHI-WASY	Shahrooz Mohajeri
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