Water Futures and Solutions: World Water Scenarios Initiative (WFaS)

Project Document

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Short title: WFaS Initiative
Full title: Water Futures and Solutions: World Water Scenarios Initiative

1. Summary

The Water Futures and Solutions: World Water Scenarios Initiative (referred to herein as the WFaS Initiative) is a cross-sector, collaborative, 5-year global initiative to develop plausible and practical scenarios of the future freshwater resource supply and demand balance and the factors affecting the balance, and to identify robust, no-regret portfolios of options for balancing water systems and changing human needs while supporting ecosystem functions against a background of climate change,. The Initiative will bring together researchers and decision makers from governmental, non-governmental organizations and private industry from a variety of sectors influencing water management and will produce:

- A new generation of global, science-based and stakeholder-informed water scenarios that are relevant and useful to the stakeholders addressed and consistent with global scenarios being developed in other sectors and disciplines, particularly those of the Intergovernmental Panel on Climate Change.
- An interdisciplinary articulation of the current scientific understanding of global water challenges, including major uncertainties, using qualitative descriptions, quantitative projections based on multiple model ensembles and comparisons, and expert opinion and analysis of available information.
- Databases, tools, and knowledge sharing networks to support scenario-based decision making at the national and sub-national scales, which will inform the global solution finding process and will stimulate the interchange of experiences, mutual learning and reciprocal capacity-building among the interested groups.

For accomplishing these scientific and policy-oriented outputs, the Initiative targets multiple objectives as follows:

1. Assess the **current and future balance of water resource availability and demand in time, space, and quality.**
2. Assess the **social contexts and governance regimes** by which the supply of and demand for water are governed and their effectiveness in the bio-physical and socio-economic settings in which they are found.
3. Create a broad range of **cross-sectoral integrated scenarios of the future state (quantity and quality) and use of water resources** by bringing together decision makers from multiple sectors to define the types of water futures that are important to consider and to develop a common vision for the future.
4. Perform a **harmonized multi-model assessment of future water resources and competing water demands** that will bring together state-of-the-art hydrological models, integrated assessment models and focused sector models. The use of multiple models will provide a measure of the modeling uncertainties.
5. Assemble information on **sector and water management options** and assess the robustness of portfolios of options across the full range of scenarios and needs of economic sectors to uncover those that work most effectively together at various scales for the conditions faced in different regions.
6. **Develop and extend knowledge sharing networks and decision support tools** to help find and disseminate the options that are most effective and robust for a particular setting.

The WFaS Initiative expands the work of the World Water Scenarios Project of UNESCO's World Water Assessment Programme, and builds on global and regional water resources modeling efforts of the European Union WATCH and SCENES projects and the Intersectoral Impact Model Intercomparison Project (ISI-MIP), providing applications for the modeling and assessment work done within these efforts. It further applies the scenarios, knowledge and analytical tools developed by global assessments in other sectors, such as the Intergovernmental Panel on Climate Change Reports, the Global Energy Assessment (GEA), Global Agro-Ecological Zones Assessments, and the Global Environment Outlook Reports, among others. The WFaS Initiative is a multi-layered, cross-sector, stakeholder informed, scenario-based assessment of the state of water resources and water demand using state-of-the-art socio-economic and hydrological models. It will coordinate its work with other ongoing scenario efforts for the sake of establishing a consistent set of new global water scenarios, based on the Shared Socioeconomic Pathways (SSPs) and Representative Concentration Pathways (RCPs) that are being developed in the context of the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5).

The WFaS Initiative will deliver water scenarios which combine *qualitative and quantitative* indicators across sectors and disciplines. Their policy relevance will be assured by including stakeholders in the scenario-building process and the assessment of management options. The scenarios will provide an internally-consistent picture of how water resources and water uses in different parts of the world may develop during the 21st century, while describing possible impacts and comparisons of various management strategies and identifying synergies and tradeoffs of the strategies developed by various actors. Quantification by state-of-the art models will complement the qualitative storylines by providing numerical information and by showing trends. The water scenarios developed aim to provide a basis for long-term strategic planning of water resource development on global, regional and national level. The scenarios will alert policymakers and stakeholders about emerging problems, and allow for the testing and analysis of a variety of management options under uncertainties. The Initiative will elaborate with stakeholders a set of robust strategies and policies, technologies and solution options, which will be tested for their effectiveness and resilience against this range of scenarios.

To achieve its objectives the Initiative will benefit from the active support by two stakeholder expert panels. The Scenario Focus Group, a representative group of policy and decision makers, will be involved in the development of the scenarios, ensuring their relevance, plausibility, and legitimacy. The Sector Actors Group will enrich the scenarios by grounding them within a range of sector perspectives and considerations.

The work will be performed through a series of stakeholder meetings to build and enrich the scenarios and identify actions and options that may be taken under each scenario. Scientific analysis and modeling will be performed between the stakeholder meetings to expand the understanding and knowledge base focusing on elements of the scenarios that have been identified to be of greatest concern. Major outputs from the Initiative will be presented at the World Water Forums in 2015 and 2018. By 2015, the qualitative scenarios will be presented along with the first round of results from the quantitative modeling assessments, a description of identified solutions options, databases of important variables, and results of assessments in various case studies.

The work flow of the Initiative in the first phase to 2015 will be organized in seven work packages (WPs), starting with the development of qualitative scenarios (WP1). Next in WP2, economic sector models and integrated assessment models will be applied with a harmonized set of assumptions and input data to produce the quantifications of variables and economic activity levels, which are required for estimating levels of future water demands (WP3) and the availability of water resources (WP4). Emerging water challenges and possible water gaps will be addressed in WP5 ('Uncovering solutions') where stakeholders will be consulted to propose alternative water allocation priorities, different water allocation mechanisms as well as technological and management options to resolve future water scarcities and reduce associated risks. The assessment framework will be developed at global scale. In addition, selected case studies will be performed on a regional/national level. WP6 will organize the integration, interaction and support of selected case studies. Throughout these activities, the coordination, communication and dissemination of the Initiative will be organized through WP7.

2. Background

2.1 Concept background

More than 10 years have passed since the last set of global water scenarios that was developed under the sponsorship of the World Water Council, during preparation of the World Water Vision (Cosgrove and Rijsberman, 2000). Since then, technology and socio-economic conditions in the world have altered dramatically, both within and outside the water sector, and change continues to accelerate. New policy initiatives such as the Millennium Development Goals have also since emerged. In 2009 the third edition of the United Nations World Water Development Report, Water in a Changing World (WWDR3) brought these issues to the forefront. In response to this challenge, the United Nations World Water Assessment Programme launched two parallel initiatives: Indicators and Supporting Monitoring for the United Nations World Water Development Report, a project to gather the data for use in indicators to facilitate the task of decision-makers, and the World Water Scenarios Project, a set of alternative futures of the world's water and its use to 2050. Based in part on the work of the World Water Scenarios Project, the WWDR4, Managing Water under Uncertainty and Risk (UNESCO, 2012), developed the issues further. At the same time UNESCO's World Water Assessment Program published two reports: the Dynamics of Global Water Futures: Driving forces 2011-2050 (Cosgrove & Cosgrove, 2012) and Five Stylized Scenarios (Gallopin, 2012).

As illustrated in Figure 2.1, scenarios of global water withdrawals pre-1980 and 1980-1995 tend to be simple extrapolations based on business-as-usual (BAU) growth assumptions. More recent scenarios typically include a broader range of assumptions of positive actions. (Cosgrove et al. (2000), Rosegrant et al. (2002), and GEO-3 (UNEP 2000))

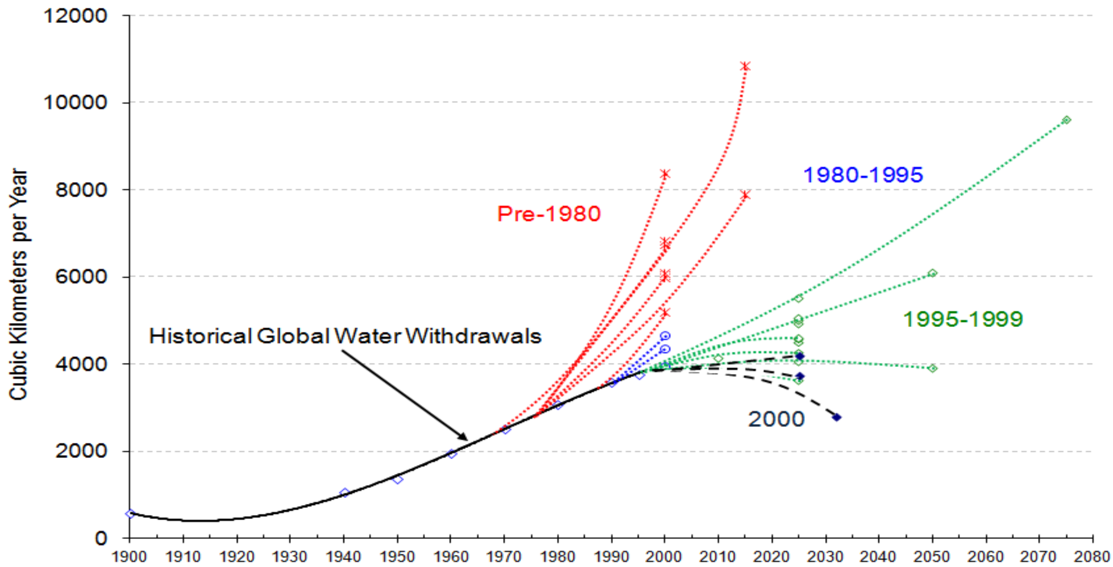

Figure 2.1: Scenarios of Water Withdrawals (Source:Peter Gleick)

A key message from these studies, and many others, is that water is not only governed or managed by water managers. Decision makers in socio-economic sectors determine the context within which water must be managed. As water use intensifies it becomes ever more important to seek water management solutions integrated across sectors. Global scenarios that have been and are being developed in other sectors provide new links to explore, and new tools have become available to develop more comprehensive and better integrated scenarios reinforced by analysis through models at the global, national and sub-national levels. Examples of these scenario building processes and tools are discussed in the next section.

The Water Futures and Solutions: World Water Scenarios Initiative started through a partnership of the International Institute for Applied Systems Analysis (IIASA), the International Water Association (IWA), the Ministry of Land, Transport and Maritime Affairs of the Republic of Korea, the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the World Water Council (WWC), and continues to add new partners. The goal of the WFaS Initiative is to provide a sound scientific basis for responding to future global water challenges by testing portfolios of possible measures, proposed as solutions, against a range of scenarios of future socio-economic changes and technological innovations in a context of global environmental challenges such as climate change and land use intensification. The WFaS Initiative brings together decision makers from around the world to share experiences, solicit their priorities and discuss their vision of possible water futures as input for developing a new generation of global, regional and country-based water scenarios and solution options to address current and future water needs.

2.2 Scientific background

Water demand has been increasing and continues to increase globally, as the world population grows and nations become wealthier and consume more. As water demands get closer and closer to the renewable freshwater resource availability, each drop of freshwater becomes increasingly important and water must be managed more efficiently and intensively. Managing water intensively requires that we know where every drop of water is at any point in time. Planning for future development and investments requires that we can also estimate this for the future. However, estimations are complicated because the future of World's waters will be influenced by a combination of important environmental, social and political factors, such as global (incl. climate) change, population growth, land use change, globalization, economic development, technological innovations, political stability and international collaboration. Climate change and other factors external to water management (such as the recent financial crisis and instability of food price) are demonstrating accelerating trends or disruptions. This creates new risks and uncertainties for water managers and for those who determine the direction of water actions. In spite of these water management challenges and the increasing complexity of dealing with them, there is only limited knowledge and data available about freshwater resources and how they are being used.

It is universally accepted that land, energy and water are an integral part of the development challenge. Close to one billion people are undernourished and another billion are malnourished. Some 1.2 billion people live in areas where there is physical water shortage, a number which is expected to grow in coming decades. A further 1.6 billion people suffer from economic water shortages, where the infrastructure to deliver clean water is not in place. Energy access is also far from universal with 1.3 billion people living without access to electricity and 2.7 billion with no access to modern and healthy forms of cooking. If development is to take place in a broad, equitable, sound and sustainable manner, clever policy and large investments are needed, in order to ensure safe, reliable and affordable access to these essential resources (Howells et al., 2013).

Increasing populations, fast growing demand in emerging economies, and existing resource intensive consumption patterns in developed countries are placing unprecedented demand on global natural resources of land, water and minerals. If current trends continue, meeting food demand by 2050 will require roughly a 60% increase in output from the world's cropland and a 70% increase in the output of meat and dairy (Fischer, 2011; Alexandratos & Bruinsma, 2012). Agricultural intensification, an important response strategy to the looming land scarcity (Lambin & Meyfroid, 2011), is inevitable when climate change mitigation and halting biodiversity loss is a prime concern. Today more than 40% of crop production is from irrigated agriculture. At the global level agriculture is the largest consumer of freshwater accounting for about 70% of human water withdrawals. An important driver of the future of the World's water demand will therefore be the efficiency at which water is used in agriculture. Nelson et al. (2010) explored the effects of a 15% increase in irrigation efficiency in developing countries and found that these do not have significant impacts in regions where climate change will increase precipitation and dietary preferences are changing towards less water-intensive crops (e.g., from rice to wheat). In contrast, such efficiency improvements are expected to make a big difference in countries with a deteriorating water balance and increasing demand for food (e.g., South Asia). Water withdrawals for irrigation are projected by FAO to increase by about 10% by 2050 (FAO, 2011). Taking into account socio-economic development and climate change impacts on crop water balance and growing season length, agricultural water withdrawals may need to increase by as much as 25% (Fischer et al., 2007). In addition, livestock is probably the largest sectoral source of water pollution, contributing to eutrophication, “dead” zones in coastal areas, degradation of coral reefs, human health problems, emergence of antibiotic resistance and many others (FAO, 2011).

Water and energy are intricately linked and demand for both is growing despite of supply constraints, increased costs and the impacts of climate change. The energy sector already accounts for 15% of the world's total water use and its needs are set to grow, making water an increasingly important criterion for assessing the viability of energy projects (IEA 2012). Already in some regions, water constraints are affecting the reliability of energy production/generation, with projected increases in vulnerability of energy systems to water constraints as rivers warm up and their flows decline under changing climatic regimes (Ackerman & Stanton 2011; Fisher & Ackerman 2011; van Vliet *et al*. 2012). As water and energy systems become more vulnerable and competition for these resources intensifies in a transforming world, modeling spatial and temporal relationships between different attributes of water and energy systems could provide further insight into the intricate and interdependent links between them.

At the same time domestic and industrial demands for water are likely to increase (Hanasaki et al., 2008). Demand for cooling water by power plants could increase due to higher temperatures and increasing electricity demand (van Vliet et al., 2012). Water also plays a key role in ecosystem functioning which provide a wide range of environmental services and goods including flood control, groundwater replenishment, shoreline stabilization, sediment and nutrient regulation, and water purification. Wetlands ecosystems, the most species-diverse habitats on earth, are especially at risk. An estimated 50% of world wetlands have disappeared over the last century (UCN, 2005; Ramsar, 2005).

The combination of these developments in food, domestic, industry and ecosystems water demand will increase pressures on the existing water resources. Sectoral studies have already shown that the required increase in crop production might be difficult to achieve due to limited water availability (Biemans, 2012) and that electricity supply can be vulnerable to climate change (Flörke et al., 2012; van Vliet et al., 2012).

Acknowledging the importance of these fundamental linkages, the climate change research community is pursuing development of a new framework for the creation and use of scenarios to improve interdisciplinary analysis and assessment of climate change, its impacts, and response options. This process includes a set of forcing pathways, known as the Representative Concentration Pathways (RCPs), to be combined with alternative shared socio-economic development pathways (SSPs) (Moss et al., 2010). Development of RCPs has been completed and these pathways are now documented in a special issue of Climatic Change (van Vuuren et al., 2011), and climate model simulations based on them are undertaken as part of the Coupled Model Intercomparison Project Phase 5 (CMIP5) (Taylor et al., 2011).

The SSPs define the state of human and natural societies at a macro scale and have two elements: a narrative storyline and a set of quantified measures that define the high-level state of society as it evolves over the 21st century under the assumption of no significant climate feedback on the SSP. This assumption allows the SSP to be formulated independently of a climate change projection. In reality, SSPs may be affected by climate change, which can be taken into account when combining SSPs with climate change projections to generate a socioeconomic-climate reference scenario (Arnell et al., 2011).

Two axes of the IPCC scenario matrix are the SSPs and RCP radiative forcing levels. Each combination of an SSP and a RCP radiative forcing level defines a family of macro-scale scenarios. For any combination of SSP and RCP there is a number of possible climate change projections that are associated with a different model of the physical climate system, adding yet another dimension to the analysis (Arnell et al., 2011).

There is increasing evidence that the global water cycle is changing due to global warming, as a result of increased atmospheric greenhouse gas concentrations. This causes alterations in precipitation, evaporation and runoff patterns around the world. In addition, the frequency and intensity of climate and hydrological extremes (floods and droughts) are likely to increase. These changes in the hydrological cycle can have large impacts on future water availability (Hagemann et al., 2011) and quality (Murdoch et al., 2000). Climate change impacts on water resources have been studied widely on different scales, varying from catchment (e.g. van Roosmalen et al., 2009) to continents (e.g. Feyen and Dankers, 2009) and the world (e.g. Alcamo et al., 2007; Arnell et al., 2011; Döll and Müller Schmied, 2012).

While most hydrological impact assessments are based on one hydrological model, the use of a multi-model ensemble of hydrological models is needed to reveal the uncertainties associated with the structure, representation of processes and parameterization of these models. Climate change impact assessments thus need to use not only multiple climate models but also multiple hydrological impact models (Haddeland, 2011). As part of the Integrated Project Water and Global Change (WATCH, 2007-2011), funded under the EU FP6, a multi-model hydrological impact assessment (Water Model Intercomparison Project; WaterMIP) was performed to provide an ensemble estimate of the current state of global water resources (Haddeland, 2011) using a new global gridded meteorological forcing dataset (0.5° x 0.5°) (Weedon et al., 2011) as input into a set of 11 macro-scale hydrological models. In addition, a multi-model ensemble of projected hydrological changes in the 21st century and related uncertainties (Chen et al., 2011) were also provided within WaterMIP based on bias-corrected general circulation model data (Hagemann et al., 2011) from the CMIP3 archive. Within the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP), a similar model protocol was followed to provide an ensemble of changes in global water scarcity under climate change during the 21st century (Schewe et al., submitted) using bias-corrected GCM output (Hempel et al., 2013) from the CMIP5 data based on the new representative concentration pathways (RCPs). However, previous global multi-model assessments of future water resources and demands focused on only climate change impacts, while socio-economic changes are expected to have strong impacts future water demands and water scarcity. A novel global water use and scarcity assessment under shared socio-economic pathways (SSPs) is provided by (Hanasaki et al., 2012a, b). In their study a series of global hydrological simulations with the H08 model (Hanasaki et al., 2008a, b) were conducted under the SSPs, taking into account different climate policy options and results of climate models. Their results suggest that by 2071-2100 the population living under severely water stressed conditions and quantitative assumptions made for SSP1-5 will reach from 39% to 55% of total global population (Hanasaki et al., 2012b).

Although multi-model approaches have recently been used in studies to make robust assessments of changes in water availability under climate change (WaterMIP, ISI-MIP), impacts of socio-economic changes (e.g. land use changes, urbanization) have not yet been taken into account by most of these studies. In addition, previous studies addressed sector specific impacts by typically focusing on one sector and using one model (Biemans, 2012; de Fraiture, 2007; Döll et al., 2009; van Vliet et al., 2012), and could therefore not quantify uncertainties or potential conflicts between different water using sectors.

Finally, none of the previous studies addressed changes in variability and its potential effects on water availability for different sectors in extreme dry or wet years. We propose in this work package to develop a set of robust and comprehensive quantitative future water scenarios based on a multi-model and a multi-sectoral approach, using the most recent climate scenarios consistent with IPCC AR5 development.

2.3 Stakeholder participation

Involvement of stakeholders as partners in co-creation of knowledge is one of the distinct features of this project. The importance of stakeholder engagement comes from recognizing multiple gaps that exist between: science and policy, policy and practice, science and practice.

The gap between policy and practice is recognized in political science, through a recent change in the understanding of policy. The introduction of the term governance over the last few decades has signalled a change in thinking about the nature of policies. The notion of government as the single decision making authority has been replaced by multi-scale, polycentric governance taking thus into account that a large number of stakeholders in different institutional settings contribute to policy and management of a resource. This change reflects a more general trend in public policy, different from the old hierarchical model in which state authorities exert sovereign control over the people and groups making up civil society. 'Governance' takes into account the increasing importance of basically non-hierarchical modes of governing, where non-state, private corporate actors (formal organizations) participate in the formulation and implementation of public policy. Governance encompasses thus as broad range of processes related to the coordination and steering of a wide range of actors by formal and informal institutions. In the water sector, the Water Framework Directive (2000/60/EC; WFD) requires the inclusion of stakeholders in the process of developing and adopting a river basin management plan. In order to improve stakeholder-based policy design, innovation and research is required in linking analytical methods and participatory approaches. Factual knowledge and analytical techniques have to be combined with local knowledge and subjective perceptions of the various stakeholder groups (Pahl-Wostl, 2002).

Problems with policy-science interactions have long been recognized. They were expressed by Caplan (1979) in his thesis of two communities (an analogy to "two cultures" conceptualized by C.P. Snow). The gap arises, according to Caplan, because researchers and policy makers inhabit two different cultures. Scientists and policy makers "live in separate worlds, with different and often conflicting values, different rewards systems, and different languages" (Caplan, 1979; Choi et al. 2005). One of the concepts (and related practices) employed to bridge science-policy gap is knowledge brokering (Sheate & Partidário, 2009; Litfin, 1994; Sverrisson, 2001; Surridge and Harris, 2007; Sterk et al., 2009; Owens and Rayner, 1999). Sarah Michaels (2009) distinguishes six strategies of knowledge brokering: informing, consulting, matchmaking, engaging, collaborating, and capacity-building. Although initially focused on one-way knowledge transmission (informing, consulting) there is a growing recognition that often better results can be achieved through more participatory strategies involving a variety of different knowledge brokering instruments such as group model building or scenarios. Intensive knowledge brokering should create and sustain the capacity for innovations. According to Michaels (2009) in building capacity parties jointly frame their processes of interaction and negotiate substance with the intent of addressing multiple dimensions of a policy problem. These negotiations continue while they consider what can be learned from doing so that it is applicable to implications of the issue, future scenarios and related concerns.

In particular, the combination of formal methods and modeling with stakeholder-based, participatory approaches has become an active area of research in integrated assessment over the last years (Pahl-Wostl et al., 1998). The experience gathered in this context will also be an important basis for the development of new approaches in water resources management. If decision stakes are high and uncertainty looms large science has to move to its post-normal stage (Funtowicz and Ravetz, 1993). New management schemes will combine "hard" problem solving and decision support techniques based on optimization and factual knowledge with "soft" stakeholder-based policy design and application (Pahl-Wostl, 2002; Swart et al., 2004).

One approach to participatory integrated assessment is to develop scenarios with stakeholders and then analyse key elements of the scenarios with a combination of participatory and modeling techniques. This approach has been already demonstrated in a number of projects, for example: SIRCH (Social and Institutional Responses to Climate Change and Climatic Hazards: Drought and Floods, EU project – see Bakker et al., 1999), SCENES (Water Scenarios for Europe and for Neighbouring States, Project within EU 6th FP – see Kamari et al., 2008; Kok et al., 2011), PSI-connect (Policy Science Interactions: connecting science and policy. Project under the EU 7th FP – see Magnuszewski et al., 2011), coastal planning for climate change (Tompkins et al., 2008). In spite of these early examples, successful involvement of stakeholders in global scenarios development remains a challenge and underutilized opportunity. The WFaS Initiative will build on these efforts and will extend them in a significant way both by expanding the scale to the global level as well as by integrating stakeholder processes with multi-model integrated assessments and hydrological modeling.

2.4 Milestones and main deliverables

Detailed milestones and deliverables are listed in the Implementation Plan in Section 5 and only a brief overview is provided here. Milestones are centered around stakeholder meetings which take place after key steps of the analysis. The first stakeholder meeting is in June 2013 when the development of the qualitative scenarios will begin. A description of the conceptual framework for the Initiative, the design of the participatory process, a review of existing quantified scenarios, a review of technological and policy and institutional management options, and of assumptions and methods for projecting trends into the future will be delivered to the stakeholders before the meeting.

After the stakeholders identify the types of scenarios, variables, and indicators that they are primarily focused on and develop narratives around them, the Project Group will develop the methods required for further describing and qualifying the scenario elements of greatest importance, prepare the methods to translate the qualitative descriptions into quantifications, assemble the databases and tools required to do so, and prepare quantitative projections of an extended set of scenario variables and activity levels. This information will then form the basis for the second stakeholder meeting in December 2013 in which stakeholders will further enrich the qualitative scenarios, reviewing the revised qualitative descriptions and quantitative information to ensure that their vision for the scenarios is appropriately represented, and further identifying types of management options to be investigated. The first round of water availability and demand modeling and assessment with multiple models can then begin in order to complete the quantification of the scenarios including analysis of model uncertainties, and the possible impacts of a limited set of management options. These will again be made available and presented to stakeholders at their third meeting in November 2014. This process will continue with additional iterations as the focus shifts to analysis of a larger array of possible solutions to the water management challenges faced. Decision support tools that integrate water resources and water demand will be created to rapidly assess a variety of options and to address emerging water gaps.

Major outputs from the Initiative will include:

- A new generation of integrated global water scenarios that are consistent in their narratives and underlying quantitative assumptions with other global scenarios.
- Policy briefs and guidance on scenario-based decision making and robust and resilient management options in a variety of settings.
- Case study reports illustrating the use of regional scenario enrichment consistent with global scale scenarios and the effectiveness of various solutions for those regions.
- A solution options toolbox for scenario-based decision making containing:
    - Methods of scenario generation and application
    - Data bases and information assembled and developed within the WFaS Initiative and necessary to perform water analyses
    - Exploratory models, impact calculators, automated checklists to assist decision support by illustrated synergies, tradeoffs, concerns, and impacts of various sets of options
    - A catalogue of solution options
    - Decision trees for mapping solutions to local conditions
- A network involving information exchange, mutual learning and horizontal cooperation to connect teams of researchers and decision-makers exploring the scenario approach at national and sub-national levels, along with an appropriate self-organizing Internet site for interactions and exchange of experiences.

Major outputs from the Initiative will be released to correspond with the timing of the upcoming World Water Forums. At the seventh World Water Forum in Korea in 2015, a report will be released describing and analyzing the WFaS scenarios, the results of the initial multi-model integrated assessment of the water scenarios, what limitations they may impose on future plans in the water-dependent sectors, and some of the options that are available today to deal with the identified problems. In addition, the globally consistent databases produced by the Initiative and the information exchange network will be released to the public. Final results of the Initiative will be released at the eighth World Water Forum in 2018.

3. Innovation and potential impacts

The WFaS Initiative addresses the multidimensional aspects of the water system and is guided by stakeholders representing these various aspects. The Initiative visualizes freshwater systems as being strongly interweaved with human activities (Economy, Society) and Nature as a whole. Dynamics and health of freshwater systems is critical to human well-being, for example. The Initiative will go beyond scenario production and model comparisons and will focus on exploring solutions and necessary innovations to address the growing water challenges. Solutions can be combinations of technological innovations, regulatory approaches, management or institutional changes that improve the balance of water supply and demand or improve water quality. Solutions will be embedded in and cut across all sectors of social and economic activities.

The various aspects of the multidimensional water system are represented in the conceptual framework of Figure 3.1, with the main drivers (shown as dimensions of Nature, Economy, and Society) at the bottom, their relations to Freshwater Systems Dynamics and resulting outcomes to Human Water Security and Freshwater Ecosystems in the middle, and the implications for Human Well-being displayed at the top. Human well-being, human water security, and freshwater ecosystem health are the three overarching central criteria used to assess the desirability of water scenarios and of the benefits created by proposed solutions. The diagram illustrates that human water security and freshwater ecosystems health are threatened by a series of stressors such as water shortage, flood risk, pollution, and river and catchment disturbance resulting from alteration of freshwater systems by human activities. Freshwater resource dynamics and water use is driven by a range of diverse factors grouped together in the areas of Nature, Economy and Society (only the major factors relevant for water scenarios are shown here).

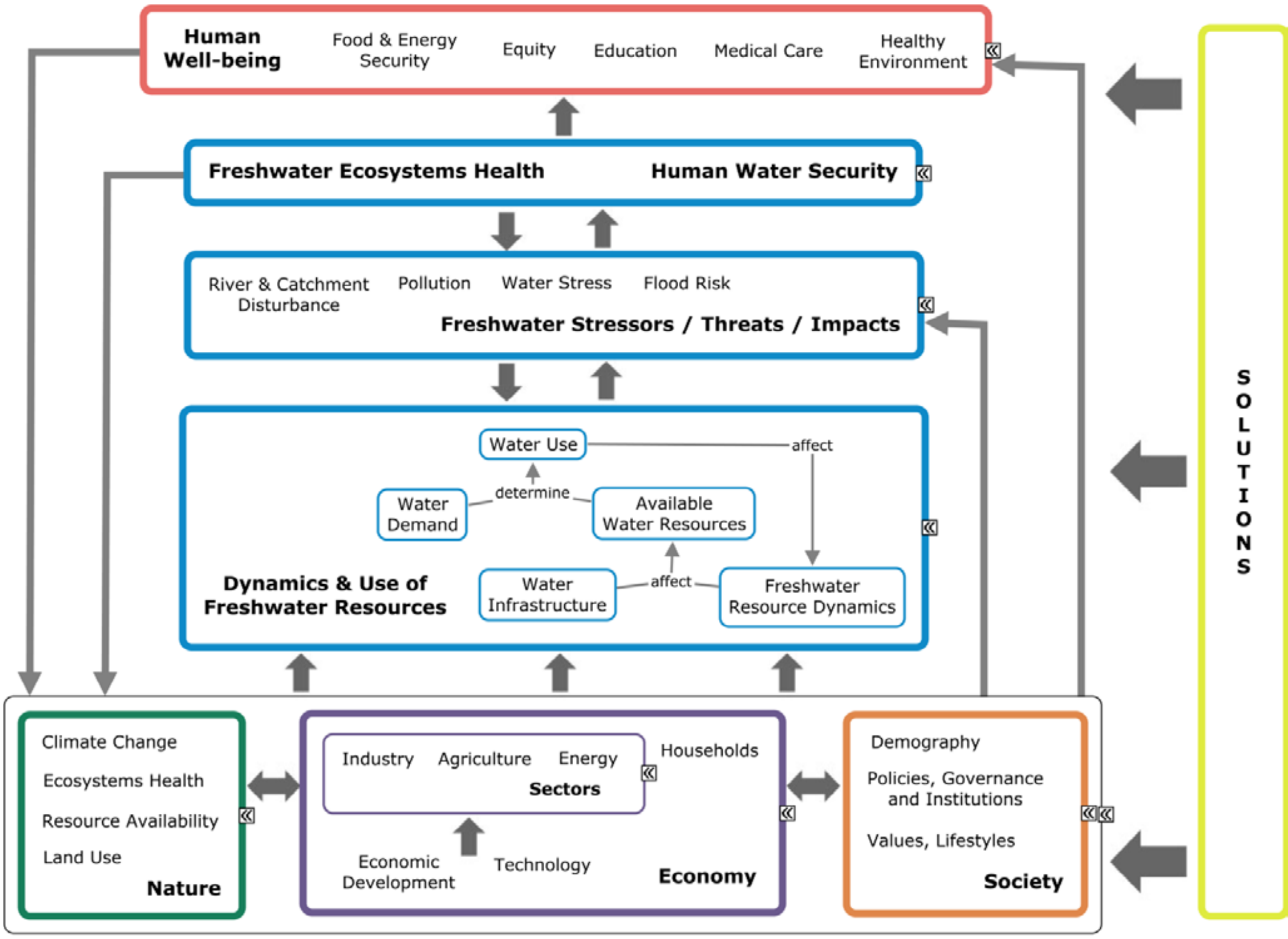

Figure 3.1 Key drivers and causal links affecting human water security, freshwater ecosystems and human well-being.

The analysis of the WFaS Initiative will be unique and is distinct from earlier water foresight studies in several ways:

- It will develop scenarios that are described both qualitatively and quantitatively, supported by information generated by multi-model assessments using new generations of socio-economic and hydrologic models.
- Scenarios will be fully consistent with and include information being generated in recent and ongoing global assessments of climate change, agriculture and energy systems.
- While focusing on the integrated assessment of water sector issues, the scenario analysis will explicitly address the water–food–energy–ecosystem nexus.
- The stakeholder-informed scenarios will be used to assess the robustness of solution options, policies and technologies, with the purpose of providing information for decision-making on water issues and challenges at multiple scales in a variety of bio-physical and socio-economic settings. The scenarios will

include major transitions which are likely to happen in coming years and decades in, for example, water governance and water related technologies.

- Scenario analysis will be accompanied by a stakeholder-led process to identify and prioritize alternative solution options and strategies to achieve desirable water futures.
- The scenarios and solution pathways will be guided by and prepared in collaboration with major stakeholders in water dependent public and private sectors, which will significantly increase both plausibility as well as practicality of these scenarios.

Through communications with stakeholder groups around the world and involving their representatives in the process, the Initiative will raise awareness of the need for this approach and the possibilities it offers for better water management and planning. By asserting the robustness of proposed development options, the Initiative will satisfy the needs of decision-makers who need to act in spite of the uncertainties they face. Sub-global case studies will provide locally adapted models of approaches that can be taken and the information and knowledge sharing networks will highlight solutions that have been effective, the bio-physical and socio-economic settings in which they have been effective, and the potential to transfer and use these solutions in other areas.

4. Organization structure of the Initiative

In order for the Initiative to accomplish its goals, an effective organizational structure will be set up comprising of five interacting groups:

1. Governing Board
2. Secretariat led by the Project Director who will also facilitate the Project Group
3. Two stakeholder groups
    a. Scenario Focus Group
    b. Sector Actors Group
4. Project Group

The Governing Board is responsible for providing annual oversight and review of the Initiative. It will include high-level representatives of the Initiative's initiating partners, as well as sponsoring, funding and collaborating agencies.

The Secretariat, based at IIASA, will provide strategic coordination, management and administration of the Initiative and will oversee communications with partners and stakeholders.

The Scenario Focus Group (SFG), a representative group of water policy and planning decision makers at the national and international level, will be involved in the development of the scenarios, ensuring their relevance, plausibility, and legitimacy. The Sector Actors Group (SAG) enriches and grounds the water scenarios by providing a range of sector perspectives and considerations during their development, to ensure their feasibility and buy-in from sector actors. The SAG will also develop portfolios of solutions for the main global challenges, which will be tested in Flagship Projects and in some cases be supported with theoretical deep-dives. Both the SFG and SAG will include representation from water rich and economically rich regions to water poor and economically poor regions.

The Project Group will be composed of the experts who will support and document the qualitative and quantitative scenario development, perform modeling and assessment work, and test management options to determine the degree to which they are robust based on strategic direction provided by the Governing Board and the substantive inputs from the Scenario Focus Group and Sector Actors Group. The Project Group ensures that the scenarios present an integrated, coherent and complete analysis of the issues and options, and are consistent with state of the art science. This will lead to some key outputs of the Initiative, which are proposals for flexible and robust solutions strategies which will themselves be developed in coordination with the SAG and SFG. The work will be performed at the global level as well as for a selected number of regions/basins or countries, including support for associated initiatives. Representatives of the sub-global initiatives will participate in the Project Group.

The relationships between the different groups are sketched in Figure 4.1.

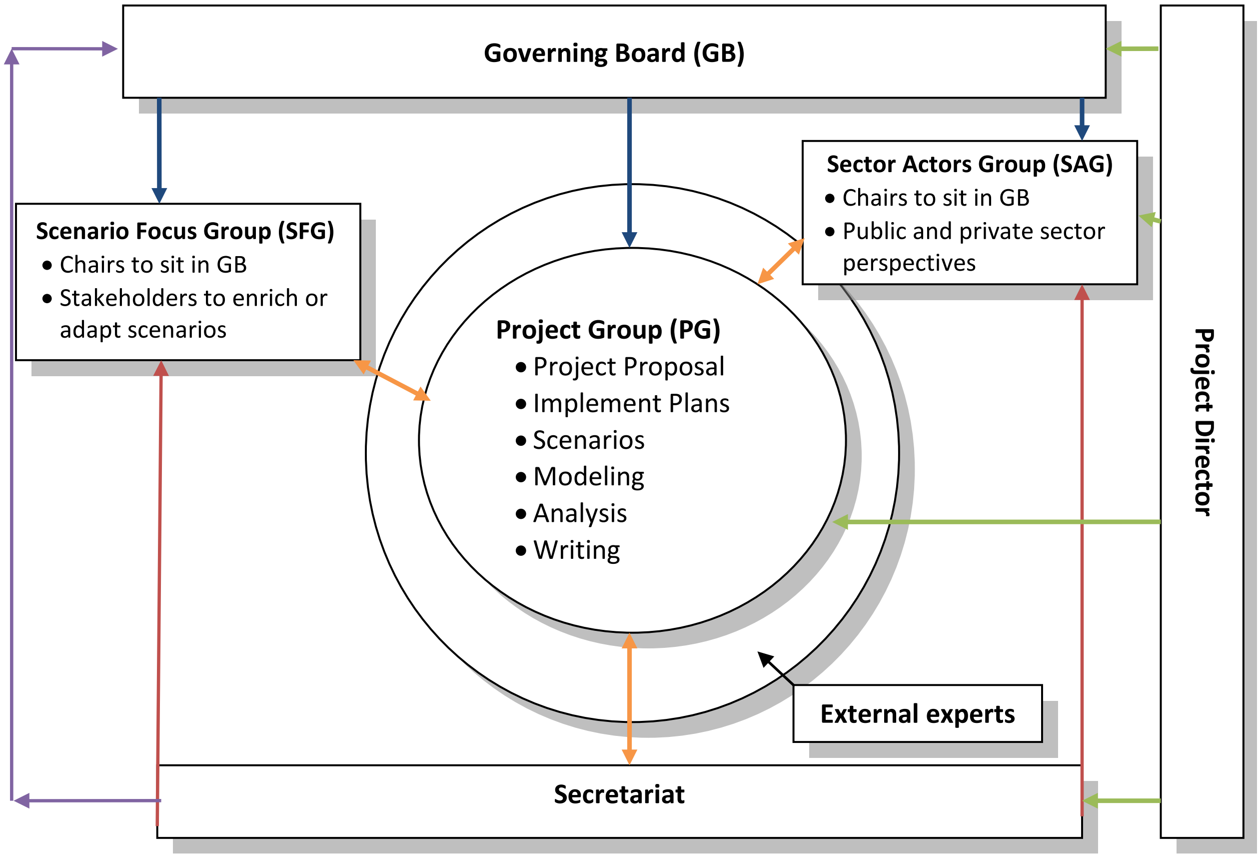

Figure 4.1: Organization Structure of the *Water Futures and Solutions* Initiative.

5. Implementation Plan

5.1 Overview

The different steps and associated work packages (WPs) of the WFaS Initiative are visualized in Figure 5.1 and summarized in Box 5.1. We start with the development of qualitative scenarios and semi-quantitative descriptions of water system variables and indicators (WP1). Activities in WP1 will build on ongoing global scenario efforts (e.g. SSP development under IPCC AR5, GEA) and will work with the Scenario Focus Group (SFG) and Scenario Actors Group (SAG) to develop and describe representative water sector pathways around a number of socio-economic development pathways (based on the SSP scenario framework).

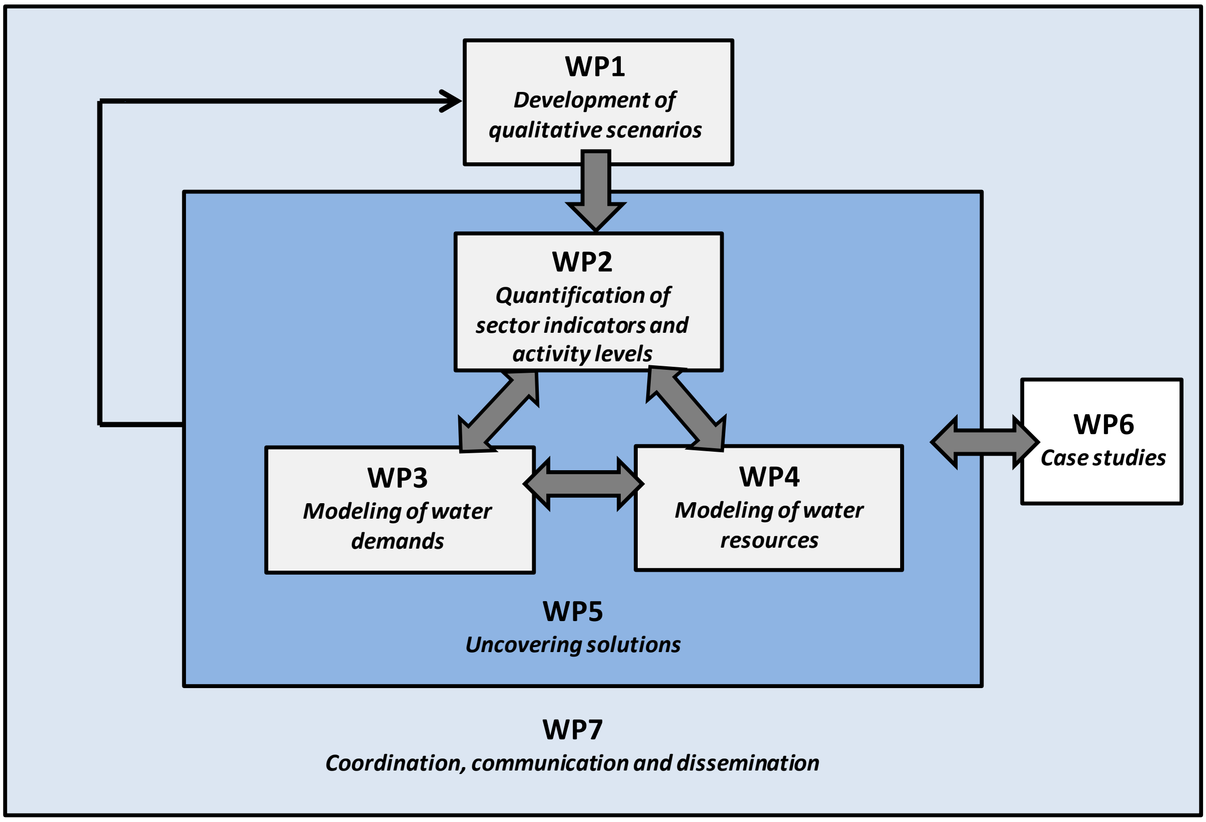

Figure 5.1: Information flow and organization of work packages (WP) in the WFaS Initiative.

Next in WP2, a suite of available simulation models (economic sector models, integrated assessment models, impact calculators, multi-region input-output economic models) will be applied with a harmonized set of assumptions and input data from WP1, to produce a harmonized dataset with quantifications of variables, indicators, economic activity levels, etc., which are relevant to and required for estimating the availability of water resources (WP4) and levels of water demands by sectors (WP3).

Trends, challenges and possible water gaps, i.e. differences in volumes of water demanded and water resources supplied as resulting from scenario quantifications in WP2, WP3 and WP4, will be addressed in WP5 ('Uncovering solutions'). In this work package stakeholders will be consulted to propose alternative water allocation priorities, different water allocation mechanisms as well as technological and management options, including water recycling/cascading, to help address future water scarcities, and reduce water-related risks. This solution finding process (WP5) may thus lead to further iterations in model simulations and possibly adjustments in the qualitative scenarios (WP1) and the modeling assumptions made in the scenario quantifications of WP2, WP3 and WP4.

The global water scenarios modelling framework includes a multi-model ensemble of both climate scenarios (based on representative concentration pathways (RCPs)) and shared socio-economic pathways (SSPs) that were produced as part of IPCC AR5, and other socio-economic scenarios. These climate and socio-economic scenarios are used in a multi-modelling framework involving sector and integrated assessment models (WP2), water demand models (WP3) and different global hydrological models (WP4) (Figure 5.2). This will result in the first set of quantified global water scenarios that include consistency in climate and socio-economic developments (e.g. population dynamics, economic development, land use changes).

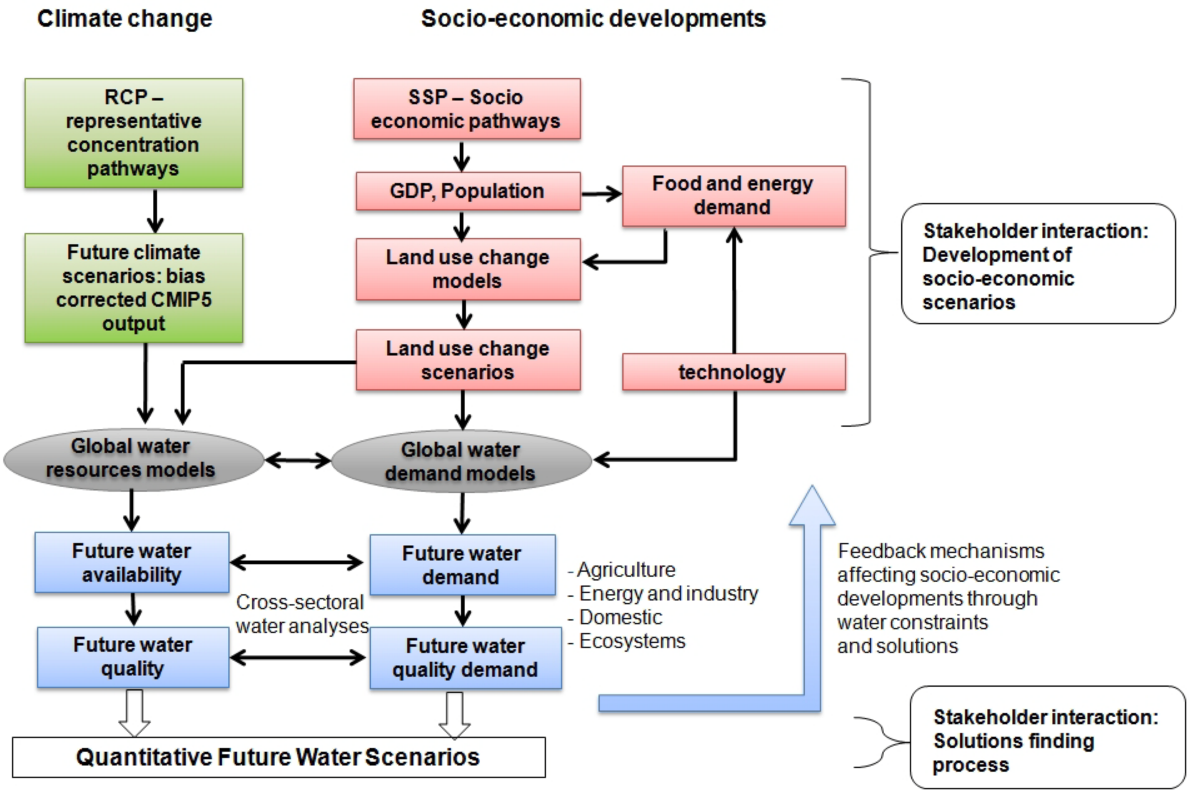

Figure 5.2: Concept of multi-model global water scenarios modeling framework

The assessment framework will be developed at global scale. In addition, selected case studies will be performed on a regional/national level. WP6 will organize the integration, interaction and support of selected case studies through several mechanisms and channels: (i) dialog with and participation in the Project Group, (ii) providing a global context and a range of scenarios for embedding case studies, (iii) provision of modeling tools and data, and (iv) sharing of stakeholder knowledge.

Coordination, communication and dissemination activities of the WFaS Initiative are bundled in WP7. One task deals with project management, coordinating modeling activities among different work packages in accordance with the project plan, with organization of the SAG, SFG and Project Group meetings. A related task in WP7 will be to facilitate and implement communication channels within the Initiative via online collaboration tools. A third task will be to make the water scenarios and outcomes of the WFaS Initiative publicly available as they are developed via online portals, scientific publications and policy briefs, websites, databases and toolboxes. Communications will take advantage of any other technologies and opportunities that can help disseminate the ongoing work and scenario results, findings and recommendations for solution strategies and funnel feedback to the Project Group.

Box 5.1: Summary of Work Packages in Water Futures and Solutions: World Water Scenarios Initiative

WP1 *Development of qualitative scenarios*: This work package provides qualitative and semi-quantitative descriptions of the core driving forces, trends, governance regimes and pressures related to water futures. It builds on and establishes the links with existing global scenario activities. It includes the development and analysis of qualitative scenarios responding to stakeholder needs and based on a dialog between the Scenario Focus Group (SFG) and the Sector Actors Group (SAG).

WP2 *Quantification of sector indicators and activity levels*: In this work package the qualitative and semi-quantitative descriptions (narratives) of indicators and drivers coming out of WP1 will be used to drive various systems models and integrated assessment models to produce related quantified indicators, variables, sector and cross-sector analyses needed as input to inform/drive the numerical simulations of water resources and water demands.

WP3 *Modeling of water demands*: Based on the qualitative information generated in WP1 and indicators and economic activity levels quantified in WP2, the aim of this work package is to estimate future water demands by different sectors and for a plausible stakeholder-selected range of different technological assumptions and options.

WP4 *Modeling* of *water resources*: The overall aim of this work package is to provide a robust quantitative assessment of future global and regional water resources. The future status of global and regional water resources for different human uses and for ecosystems will be quantified using a multi-model framework of global water resources models.

WP5 *Uncovering solutions*: This work package will evaluate the balances (in space and time) of water supply and demand resulting from the harmonized multi-model assessments in WP2, WP3 and WP4. Water allocation mechanisms and priorities proposed by stakeholders as well as optional political, managerial, and technological solution measures which have been identified by the stakeholders will be tested in an iterative process for robustness under each of the scenarios. The impacts and effectiveness of various strategies and the uncertainty of results will be communicated to stakeholders and decision-makers.

WP6 *Case studies*: A similar approach, fully consistent with the global assessment, will be followed in selected regional/national initiatives which will be carried out by local actors with support from and feedback to the Project Group.

WP7 *Coordination, communication and dissemination*: This work package is responsible for effective coordination and financing of activities among different work packages in accordance with the project plan and for developing and implementing communication within the project via online collaboration tools. WP7 will produce consistent sets of materials, publications, websites, databases and toolboxes, taking advantage of available technologies and opportunities, to disseminate the water scenarios, tools, findings and recommendations developed by the Initiative.

WP1: Development of qualitative scenarios

WP lead: IIASA. (suggested: Piotr Magnuszewski)

Objectives of WP1:

- To build a conceptual framework for development of scenarios and solutions
- To develop a set of qualitative water scenarios consistent with IPCC shared socio-economic pathways (SSPs) and representative concentration pathways (RCPs)
- To elaborate semi-quantitative socio-economic and water dimensions of scenarios
- To design and execute participatory process involving stakeholders in the development of scenarios and solutions
- To integrate developments in other work packages into a consistent representation of scenarios and solutions using the conceptual framework

This work package provides an overall conceptual framework for development and integration of scenarios and solutions in the project. It builds on and establishes the links with existing global scenario activities (e.g. SSP development under IPCC AR5, GEA). It provides qualitative and (where it is needed) semi-quantitative descriptions of both socio-economic and water dimensions. WP1 explores qualitatively a wide range of dimensions in social, economic and environmental areas (described often as drivers) including governance regimes and lifestyle changes. These dimensions are used as a (semi-quantitative) input to system models and integrated assessment models in WP2. These socio-economic dimensions are further explored qualitatively to assess its impacts on water demand, dynamics of freshwater systems and consequently on human well-being and freshwater ecosystems health. WP1 provides consistent qualitative narratives of driving forces that affect the whole integrated freshwater system that are used as a background for development of solutions. These narratives will be updated based on quantitative results from WP2, WP3 and WP4.

A distinct project feature is to engage stakeholders as co-producers of the scenarios. WP1 engages stakeholders in the process of scenarios development and identification of potential solutions. The stakeholder processes are used to assess their needs and make scenarios relevant for them. Through a dialog within and between the Scenario Focus Group (SFG) and the Sector Actors Group (SAG) the scenarios are analyzed and improved, potential solutions identified and assessed.

The results of WP1 will inform the quantification of socio-economic dimensions including economic activity levels by sector in WP2, and will feed into the calculation of water demand (WP3) and the water resources modeling work (WP4). During stakeholders meetings solutions will be identified and explored (WP5).

Description of Work of WP1

Task 1.1 Development of a conceptual framework underpinning scenarios and solutions

The Project Conceptual Framework (see Figure 3.1 in Section 3) is a representation of the Global Freshwater System integrated with relevant dimensions of Society, Economy, Nature and human Well-being. It will also include the Solutions to address water-related issues embedded in the above dimensions. The conceptual framework consists of systems *dimensions* and *linkages* between them. Overall system performance is represented by *Critical Dimensions* (selected among all available dimensions), that are used to evaluate scenarios and solutions.

The conceptual framework includes key socio-economic dimensions (organized in the areas of *Nature*, *Economy*, and *Society*) acting as driving forces and pressures, that affect future water demands and resources. These drivers modify freshwater systems dynamics and resulting outcomes, that affect different dimensions of human well-being, in particular human food and water security as well as human and ecosystem health. Human well-being, human water security, and freshwater ecosystem health are three central criteria to assess the desirability of the scenarios and benefits of proposed solutions. The distinction between drivers and outcomes should not obscure the fact that *outcomes* also affect *drivers,* forming a variety of feedback loops that are represented in the framework

The framework has both written (as a document) and a dynamic representation as an interactive concept diagram with links to relevant resources. This diagram will evolve during the project serving as a knowledge base for all groups involved in the project.

Task 1.2 Design and execution of participatory processes for SFG and SAG

This task defines the participatory approach to be used throughout the project and during the Scenario Focus Group (SFG) and Sector Actors Group SAG meetings. Stakeholder participation is critical to the project success as they are providing an application perspective to utilize project results for public and private sector. Stakeholders are engaged in the following activities:

- understanding and prioritizing major water-related challenges
- enhancing and elaborating qualitative water scenarios (narratives)
- defining a set of policies consistent with the scenarios and socio-ecological conditions
- providing input for semi-quantification of drivers necessary for modeling purposes (in Task 1.6)
- specifying a set of sectoral actors choices and priorities for scenarios policies in different socio-ecological conditions
- suggesting, defining, and evaluating a wide range of solutions (both directly water-related as well as sectoral solutions with strong water impacts)
- creating a “desirable future” scenario using backcasting (in Task 1.5)

The task includes the design of stakeholder processes during the meetings and interactions between the meetings. It also includes process facilitation of the meetings of the SFG and the SAG to create conditions for knowledge co-production as well as elicit technical information, strategic priorities, and other scenario-relevant knowledge. The work will be assisted by facilitators with an extensive expertise in stakeholder driven processes.

Task 1.3 Review of existing data and existing quantified scenarios, and visualization of trends for variables/descriptors in the conceptual framework

This task will populate the critical dimensions of the conceptual framework with time series data of the period 1985 to 2010 to show for different regions and river basins the trends in dynamics of freshwater systems. This empirical quantified information will be provided to the meetings of the Scenario Focus Group (SFG) and the Sector Actors Group (SAG) to assist their deliberations and improvements of water scenarios elements. This Task also includes a review of the methods and assumptions used in existing quantified scenarios.

Task 1.4 Development of qualitative water scenarios

Water Scenarios in the project are developed to describe and represent consistent and plausible futures combining socio-economic pathways with water specific elements as well as their impacts on human well-being and ecosystems health. The water scenarios are consistent with IPCC SSPs but expand them to include water-specific elements. Each of the water scenarios will also be linked with an RCP.

This task focuses on developing a set of qualitative (narrative) water scenarios. Later (WP2, WP3, WP4), they will be quantified using integrated assessment models, system models, and hydrological models to produce quantitative water scenarios. The complete water scenarios combine in a consistent way both quantitative (future values of water system dimensions) and qualitative (narratives) parts. Where quantitative modelling is not available, solutions will be explored using qualitative and semi-quantitative methods.

The process of qualitative scenarios development will be undertaken with a strong two-way interaction with stakeholders.

Task 1.5 Development of an “desirable future” scenario using backcasting

The scenarios in the Task 1.4 are developed with the future orientation. In parallel one additional scenario will be developed using a backcasting technique, starting from the vision of a desirable future and arranging all necessary transitions while proceeding back in time towards the present. This additional scenario will be tested for robustness i.e. to what extent it works with different assumptions (and associated uncertainties) about drivers (however some drivers can be modified in the process of designing the desired path).

Unlike other scenarios that are developed by the Project Group and improved by stakeholders this one is developed mostly by stakeholders with an input from the Project Group.

Task 1.6 Development of selected semi-quantitative variables of water scenarios

The dimensions to be elaborated include a set of variables, processes and components of human-environment systems that provide the building blocks for further constructing of the quantitative aspects of scenarios. As input to the modeling in other work packages this Task will deliver expert estimations of direction and magnitude of trends in water system elements expressed in semi-quantitative terms. They are expressed in terms of statements such as *high* or *low* population fertility, *slow* or *fast* adoption of technologies, *high* rates of GDP growth, *gradual* decrease of trade barriers, etc. To assist different WFaS collaborators (in WP2 to WP6) in model implementation and harmonization of numerical assumptions, WP1 will develop an additional guidance on the interpretation and use of selected variables in numerical scenario analysis and model parameterization.

All elaborated dimensions are harmonized with and extend the other ongoing global scenario work, notably the IPCC SSP scenario elements of population growth, GDP growth, and future rates of urbanization.

Task 1.7 Linking scenarios with solutions

The solutions options identified in the area of water allocation as well as for reducing sectoral water demand and enhancing water supply are developed in WP5 with the support of stakeholders (SFG, SAG). In some cases the evaluation of these options may suggest a revision of particular scenario assumptions, adaptation of scenario storylines or generation of additional branches of scenarios. This task intends to establish the necessary information links between WP1 and WP5, to provide relevant feedback to SAG and SFG, and where necessary to assist with associated scenarios refinements.

Key Deliverables

- D1.1 (June 2013, modified later) Document presenting the conceptual framework of main drivers, processes, water dimensions and outcomes related to freshwater systems.
- D1.2 (June 2013, modified later) Interactive concept diagram representing dynamically the conceptual framework with links to the relevant resources.
- D1.3 (June 2013) Document with the values of critical dimensions and their trends during 1985-2010.
- D1.4 (June 2013) Preliminary qualitative scenarios
- D1.5 (June 2013) Stakeholder process design document
- D1.6 Report on conclusions of SFG and SAG meetings covering a) usefulness and plausibility of set of qualitative scenarios (including trends in critical dimensions) and b) approach for identification of solutions including policy and institutional options to address water resource management issues (completed by Secretariat by July 15).
- D1.7 (July 2013) Revised qualitative scenarios
- D1.8 (October 2013) Report with description, direction and documentation of semi-quantitative values and trends of selected scenarios' dimensions.
- D1.9 (January 2014) Progress report on development of policy, institutional, technological and behavioral options for solutions based on outputs from SFG/SAG.
- D1.10 (January 2014) "Desirable future" scenario developed using backcasting
- D1.11 (???) Revised qualitative scenarios based on the outputs of quantitative models and developed solutions.

Deliverables 1.1, 1.3 and 1.4 are to be sent as background information to the SFG and SAG before their meetings. Deliverable 1.6 will be send to the SFG and SAG when complete, as well as to the Project Group before their meeting 17-19 July 2013.

Milestones

- M1.1 (17-19 June 2013) First meeting of SFG
- M1.2 (19-21 June 2013) First meeting of SAG

- M1.3 (2-4 December 2013) Second meeting of SFG/SAG to further enrich scenarios and review assumptions and methods for quantification
- M1.4 (November 2014) Third meeting of SFG/SAG

WP2: Quantification of sector indicators and activity levels

WP lead: IIASA (to be determined)

Objectives of WP2

- Transfer qualitative scenarios into quantitative projections of drivers
- Quantification of extended set of drivers, indicators and economic sector activity levels
- Evaluate uncertainty of projected changes in drivers and indicators
- Quantify impacts of proposed water solution options on quantified drivers, indicators and economic activity levels

This work package serves the quantification of economic sector activity levels and indicators, as an intermediate step between the qualitative scenario development (WP1) and quantification of water demand (WP3) and quantitative water resources modeling (WP4). To the extent possible, qualitative and semi-quantitative scenario descriptions, developed in WP1 and other ongoing global scenario efforts, will be translated into economic activity levels and other quantifiable variables for analysis by the mathematical models used for water-related simulations in WP3 and WP4. For this purpose, a variety of sector models, integrated assessment models, bio-geographic models, biophysical process models, and climate change impact models available at WFaS partner institutions will be employed, driven with a harmonized set of assumptions and input data derived from WP1. Themes/variables in WP2 will include: population by age, sex and education; rural and urban population shares; per capita GDP growth; economic structure by broad sectors; food consumption and food diets; crop and livestock production; livestock system; rain-fed cultivated and irrigated land; land use by broad classes; energy final demand by sectors; portfolio of primary energy sources used; greenhouse gas emissions; international trade; trade-embedded land and water resources. Researchers responsible for this work package will also assist with exploring the quantitative impacts of various water solution options proposed in WP5.

Description of Work of WP2

Task 2.1 Preparation of harmonized input data for simulation models participating in WP2

Input data of drivers used in participating models will be collected from a variety of existing data sources and ongoing scenario efforts. Some data will be already available in quantitative terms, but other information is available only as qualitative descriptions or semi-quantitative ordinal values (in qualitative scenarios developed in WP1) and may require additional interpretation, quantified assumptions, model parameterizations or spatial downscaling/attribution to be of use to the models in WP2. For instance, numerical data of population trends, migration, per-capita water use or economic growth are available but generally on an aggregate country level, while spatially variable datasets, at regular grids or by river basins, are required for water demand and water resources modeling. Spatial quantitative information is also needed for land use changes, notably for irrigated agricultural land. This Task will develop transparent procedures to deal with the specific input data requirements of participating models in WP2.

Task 2.2 Harmonized model simulations and quantitative projections of an extended set of scenario variables and economic activity levels

A suite of available simulation models (economic sector models, integrated assessment models, bio-geographic and physical process models, impact calculators, multi-region input-output economic models) will be applied, using a common set of assumptions and scenario input data from WP1, to produce in a harmonized fashion respective quantifications of variables, economic activity levels, etc., which are relevant to and required for estimating the availability of water resources (WP4) and levels of water demands by sector (WP3). The modeling in WP2 will cover combinations of input data from different IPCC representative concentration pathways (RCPs) and socio-economic pathways (based on SSP quantifications and WP1 scenario efforts). Table 5.1 gives an overview of the methods/models used in WP2 for the quantification of variables and indicates the themes/variables covered.

Table 5.1: Models used for quantification of the key drivers and activity levels affecting water demands and water resources

Models/Methodology	Institution	Theme/Variables
Population cohort projection model; quantification of SSP drivers	IIASA POP; Samir KC	Time-series of population numbers by age, sex and education; by country
Urbanization scenario calculator; quantification of SSP drivers	NCAR; Brian O'Neill	Time-series of urbanization rates by country
GDP scenario calculator; quantification of SSP drivers	IIASA ENE; Keywan Riahi	Time-series of per capita GDP by country
Climate and Earth System models	CMIP5/ISIMIP; Michelle van Vliet, Martina Flörke	Bias corrected GCM output from CMIP5 (ISIMIP forcing on 0.5°)) and RCM data from CORDEX
Global Agro-ecological Zoning model (GAEZ)	IIASA WAT; Günther Fischer	Agricultural land productivity, crop suitability, rain-fed and irrigated crop yields, irrigation water requirements; global 5 arc-minute gridded data for historical and future climate
World Food System (WFS) model	IIASA WAT; Günther Fischer	Time-series of agriculture production by commodity groups, cultivated land use, harvested areas, fertilizer use, livestock numbers, food and feed consumption, agricultural trade, food security indicators; by country/region
EPIC	IIASA ESM; Marijn van der Velde	Crop yields, crop water requirements, crop nutrients/fertilizer use
GLOBIOM	IIASA ESM; Peter Havlik	Time-series of land use by broad classes, animals by livestock systems, agricultural production by major crop groups, food consumption, agricultural inputs
Multi-region multi-sector input-output model (MRIO)	University of Maryland; Laixiang Sun and Klaus Hubacek	Economic structure by sectors, sector production levels, intermediate and final consumption by sector, trade flows, embedded GHG emissions, embedded water
IMAGE	PBL; Detlef van Vuuren	Integrated assessment model covering land use, aggregate level of economic activities, crop and livestock production and demand, energy production and demand, greenhouse gas emissions, biodiversity losses
LANDFLOW	IIASA WAT; Sylvia Prieler	Time-series of tracking commodities and embedded land, water and nutrients from production, via trade, to apparent final consumption.
MESSAGE	IIASA ENE; Keywan Riahi	Integrated assessment model of energy final use by sector, portfolio of primary energy sources, energy conversion technologies, greenhouse gas emissions, energy access/security.
Policies, governance, institutions; concepts, classifications, indicators	University Osnabrück, Claudia Pahl-Wostl	National governance indicators, water governance indicators for selected countries and basins.

Task 2.3 Review, post-processing and integration of quantified variables and sector activity levels

This Task will retrieve the quantified information produced by participating models in Task 2.2. Standardized input data and various scenario output datasets obtained in simulations under WP2 will be made available within the WFaS Initiative as part of a data warehouse. Results will be reviewed and post-processed for presentation to SAG/SFG panels and for further analysis and use in WP3, WP4 and the solution finding process that will be set up in WP5.

Task 2.4 Impacts of water solution options on quantified variables and sector activity levels

This Task is included to allow for revisions in quantified activity levels in response to WP5 solution options or due to WP1 scenario revisions. It will use information from tasks 2.2 and 2.3 to assist the integrated solution finding process in WP5 with the possible implications of water solution options on modeled sector activity levels.

Key Deliverables

- D2.1 (October 2013) Draft document presenting the quantified critical dimensions and other indicators.
- D2.2 (June 2014) Document/chapter presenting annotated framework of sectoral quantitative scenarios including critical dimensions and other indicators.
- D2.3 (December 2013) First draft of quantified variables and economic activity levels for use in WP3, WP4 and WP5
- D2.4 (June 2014) Database of quantified scenario variables and economic activity levels from WP2 models.

Milestones

- M2.1 (October 2013) Availability of SAG/SFG guidance for model implementation of water scenario elements.
- M2.2 (December 2013) Release of harmonized input data sets to WP3, WP4 modeling teams

WP3: Modeling of water demands

WP lead: (proposed: CESR, Martina Flörke)

Objectives of WP3

- Employ SAG/SFG expertise to review and refine methodologies for estimation of sectoral water demands.
- Estimate water demand under various scenarios combining climate change projections (by RCP), socio-economic development pathway (based on SSP framework), and water system pathways.
- Quantify magnitude, impacts, uncertainty of proposed solution options on water demand and related activity levels.

Task 3.1 Review and development of methodologies for quantifying water demands

In collaboration with stakeholder inputs from WP1 and using economic activity levels quantified in WP2, this task will review methods and assumptions for estimating demand in various sectors from existing studies and will define and develop appropriate estimation techniques for WFaS. As required for applying these methodologies, this Task will also include consolidation and post-processing of results from WP2 for input to water demand quantification in Task 3.2.

Task 3.2 Estimation of water demands for different quantifications of drivers and activity levels

Using the methodology established in 3.1, this Task will quantify the demand for water in different sectors, i.e. agriculture, households, energy, industry, and water required for natural ecosystems (see Table 5.2). Estimates will be produced at agreed time steps (e.g. monthly values) and spatial resolution (e.g. for a 0.5 degree latitude/longitude grid), and will indicate the water quality required for use in these sectors.

Table 5.2: Models used for quantification of water demand by sector (including ecosystems)

Models/Methodology	Institution	Theme/Variables
WaterGAP	Kassel University (Germany), Frankfurt University (Germany); WaterMIP, ISI-MIP	Water demand in agriculture (irrigated crops, livestock), energy production, manufacturing, and domestic use.
H08	National Institute for Environmental Studies (NIES, Japan) ; WaterMIP, ISI-MIP	Water demand in agriculture, industry, domestic use, and for ecosystems (environmental flows).
PCR-GLOBWB	Utrecht University (The Netherlands); ISI-MIP	Water demand in agriculture, industry (including energy), domestic use.

Models/Methodology	Institution	Theme/Variables
KWR models	KWR Watercycle Research Institute (The Netherlands)	Household water demand
LPJmL	Potsdam Institute for Climate Impact Research (PIK; Germany) and Wageningen University (The Netherlands)	Water allocation for food production
WFS/GAEZ	IIASA WAT (Austria)	Water requirements for irrigated crops production and livestock
VIC-RBM	Wageningen University (The Netherlands), University of Washington (USA)	Water for electricity production (thermoelectric and hydropower)
Global Environmental Flow calculator	International Water Management Institute (Smakhtin, IWMI) and other environmental flow calculation techniques	Water allocation for ecosystem health

Task 3.3 Consolidation and post-processing of results from water demand modeling

This Task compiles a database of water demands at agreed spatial and temporal resolution. It will retrieve and post-process the water demand quantified by the modeling teams in Task 3.3. Various scenario output datasets obtained in simulations under WP3 will be made available within the WFaS Initiative as part of a data warehouse. Results will be prepared for presentation to SAG/SFG panels and for further use and analysis in WP5.

Task 3.4 Impacts of demand-oriented water solution options

This Task will use information from Tasks 3.2 and 3.3 to assist the integrated solution finding process in WP5 with the impacts of demand-oriented water solutions. It will analyze causes and trends of changes of water use efficiency parameters (related to technological innovations) and will compile various response functions, cost estimates, etc.

Key Deliverables

- D3.1 (October 2013) Paper presenting methodology for estimating water demand by sector
- D3.2 (mid-2014) Chapter/paper presenting new set of global water demand scenarios under future climate change and socio-economic changes, highlighting critical regions where cross-sectoral conflicts for water (including ecosystem requirements) are expected to increase
- D3.3 (mid-2014) Spatial database of water demand by sector under different scenarios
- D3.4 (end of 2014) Document/chapter presenting significance and impacts of proposed solution options on water demand and related economic sector activity levels.

Milestones

- M3.1 (October 2013) Release of data sets by WP2 modeling teams
- M3.2 (October 2013) Availability of SAG/SFG guidance for model implementation of water scenario elements addressing water demand.

WP4: Modeling of water resources

WP lead: WUR/NVE (suggested: Ludwig Fulco, Ingjerd Haddeland)

Objectives of WP4

- Undertake multi-model ensemble of water resources scenarios under multiple combinations of climate model projections (multiple RCPs and climate models), socio-economic development pathways (based on SSPs)
- Analysis of water resources availability, variability, and risks to human and ecosystem water security
- Quantification of significance, uncertainty and impacts of proposed solution options on water resources.

The overall aim of this work package is to provide a robust quantitative assessment of future global and regional water resources using a multi-model framework. The modeling will be done with multiple global hydrological models and land surface schemes to produce multi-model ensembles and estimates of associated model uncertainties. The water resources modeling teams will work with a common set of harmonized input data of demographic, economic, climate and land use drivers. Where possible, they will work with common geographical datasets (e.g. land use). Assumptions will be closely coordinated with the economic sector/indicator modeling (WP2) and with water demand modeling teams (WP3). In response to the water solutions process in WP5, the modeling of water resources may be done iteratively to allow for refinement of both the models and scenarios and test the effectiveness of selected sets of water solution options. Standardized input data and various water resources scenario output datasets will be made available within the WFaS Initiative as part of a data warehouse. Results will be prepared for presentation to SAG/SFG panels and for further analysis in WP5.

Task 4.1 Data consolidation of quantitative drivers used as inputs to hydrological models

Input data of drivers and economic activity levels will be collected from WP2 model calculations. Some data may require additional interpretation or spatial attribution to be of use to the models in WP4. For instance, numerical predictions of population numbers, per-capita water use or economic activities are available but generally on an aggregate country level. This Task will develop transparent processes to deal with the specific input data requirements of participating models in WP4.

Task 4.2 Global multi-model ensemble of water resources scenarios

This work package of the WFaS Initiative will be developed based on a multi-model assessment approach. A multi-model ensemble approach of both climate and hydrological models is proposed in order to develop robust future water scenarios tested against a large range of scenario and model uncertainties (Haddeland, 2011). The use of multiple models is necessary to account for uncertainties in both water availability and demand, and to generate robust future scenarios of water resources. For example, projected changes in levels and spatial patterns of rainfall under global warming vary significantly between different climate models. Uncertainties also exist in the responses of different hydrological models to changes in future climate due to uncertainties in the structure and parameterization of global hydrological models (Haddeland et al. 2011; in review, Hagemann et al. 2012). Modelling teams that could be involved in this global multi-model water resources assessment are listed in Table 5.3.

Table 5.3: Potential participants in multi-model assessment of water resources

Models	Institution	Theme/Variables
WaterGAP	Kassel University (Germany), Frankfurt University (Germany); WaterMIP, ISIMIP	Water availability; Reservoir impacts; Water demands by aggregate sector; Water quality (water temperature, and other parameters)
H08	National Institute for Environmental Studies (NIES, Japan) ; WaterMIP, ISIMIP	Water availability; Reservoir impacts; Water demands by aggregate sector; Environmental flows
PCR-GLOBWB	Utrecht University (The Netherlands); ISIMIP	Water availability; Reservoir impacts; Water demands by sector (surface water and groundwater); Water quality (water temperature)
LPJmL	Potsdam Institute for Climate Impact Research (Germany) and Wageningen University (The Netherlands); WateMIP, ISIMIP	Water availability; Reservoir impacts; Irrigation water use and agricultural production; Environmental flows (in preparation) and dynamic vegetation
VIC	Wageningen University (The Netherlands), Norwegian Water Resources and Energy Directorate (Norway); WaterMIP, ISIMIP University of Washington/Princeton University (USA)	Water availability; Reservoir impacts; Irrigation water use; Water use energy (thermoelectric power); Water quality (water temperature)
WBM	CUNY (USA); ISIMIP	Water availability; Reservoir impacts; Irrigation water use; Water quality (water temperature and other parameters (static))
ORCHIDEE	Institut Pierre Simon Laplace (France), Laboratoire des Sciences du Climat et de l'Environnent (France); WaterMIP, ISIMIP	Water availability; Dynamic vegetation
JULES	Centre for Ecology and Hydrology (UK), Hadley Centre (UK), University of Exeter	Water availability; Dynamic vegetation

Models	Institution	Theme/Variables
	(UK); WateMIP, ISIMIP	
MPI-HM	Max-Planck-Institute for Meteorology (Germany); WaterMIP, ISIMIP	Water availability; Irrigation water use
MATSIRO	IIS, University of Tokyo (Japan); WaterMIP, ISIMIP	Water availability; Groundwater
DBH	IGSNRR, Chinese Academy of Sciences (China); ISIMIP	Water availability
GWAVA	Centre for Ecology and Hydrology (NERC CEH); WaterMIP	Water availability
HTESSEL	Centro de Geofisica da Universidade de Lisboa (FFCUL, Portugal); WaterMIP	Water availability
MacPDM	University of Reading (UK), University of Nottingham (UK); WaterMIP, ISIMIP	Water availability

As a key output of the WFaS Initiative, the multi-model assessment will estimate future availability (and selected indicators of water quality; details to be determined) of water resources (in space and time) under various scenarios combining climate change (by RCP and climate model), socio-economic development pathways (based on SSP framework).

Task 4.3 Review and post-processing of results from hydrological modeling

This Task compiles a database of water resources at agreed spatial and temporal resolution. It will retrieve and post-process the simulated results of water resources quantified by the modeling teams in Task 4.2. The output of this post-processing step will be a set of water resources indices representing changes in the status of annual mean water resources and hydrological extremes (i.e., floods and droughts). The water resources scenario output datasets obtained in simulations under WP4 will be made available within the WFaS Initiative as part of a data warehouse. Results will be summarized for presentation to SAG/SFG panels and will be used as an input into WP5.

Task 4.4 Impacts of technological water solution options on water resources

Participants of the multi-model water resources assessment in Task 4.2 will be asked to quantify the hydrological impacts of water supply oriented solution options proposed by SAG/SFG experts as part of finding stakeholder-led integrated water solutions in WP5.

Key Deliverables

- D4.1 (June 2014) Database of spatial/temporal water resources (individual models and ensemble).
- D4.2 (October 2014) Report presenting new set of multi-model based global water resources scenarios under future climate change and socio-economic changes.
- D4.3 (December 2014) Document/chapter presenting significance and impacts of proposed water solution options on water resources availability.

Milestones

- M4.1 (October 2013) Release of data sets by WP2 modeling teams
- M4.2 (October 2013) Availability of SAG/SFG guidance for model implementation of water scenario elements addressing water resources.

WP5: Uncovering solutions

WP lead: IIASA (in collaboration with IWA and USF)

Objectives of WP5

- Identify and elaborate technological water solution options.

- Identify and elaborate policy and institutional options for implementation of water management solutions
- Identify and elaborate strategies for closing water gaps
- Evaluate indicators of human well-being under different scenarios and water solution strategies
- Quantify the developments of the water-food-energy-ecosystem nexus under climate change and socio-economic developments

Through comprehensive analysis of a range of qualitative and quantified scenario outcomes, this work package will elaborate and communicate possible robust solution strategies, i.e. portfolios of political, managerial, investment and technological solution options, to deal with future changes, variability, and uncertainty of water resources and demand due to uncertain climate change impacts, technological development, and uncertain future socio-economic and political conditions. Data, modeling and knowledge of the Initiative will be made available and prepared for effective use in decision support. Through closing water gaps in the scenario analysis, this work package will take input from and provide feedback to the Scenario Focus Group and Sector Actors Group, so they can adapt/enrich the scenarios and contribute to identifying solution strategies.

The work package will take a holistic approach to uncovering water solutions. Water supply oriented solutions will deal with water storage options, will consider wastewater treatment options and water cascading, explore desalination and possibly other non-conventional measures to increase the availability and resilience of water resources. Technological options to improve water use efficiency, i.e. to increase output per unit of water used for water-dependent goods and services, will be a second direction of searching for solutions. Third, it may be necessary to adjust activity levels in sectors requiring large amounts of water inputs (such as agriculture) or to substitute water-intensive production through trade or alternative products. Finally, future water solutions will critically depend on governance mechanisms and institutions used to manage water systems and control water use.

Task 5.1 Selection of technological water solutions to enhance water supply

This task will be led by IWA. It will explore different technological solutions to deal with the main water challenges in the 21st century from the water resources side through increasing water supply, enhanced utilization and recycling of surface water and groundwater, improved management of water resources and through measures to reduce seasonal and interannual variability of water resources. It may investigate new concepts such as harnessing nature and environment – this would imply an intelligent landscape design using ecosystem services in a more effective way (e.g. Smith, D. M. and Barchiesi, S., 2009).

Task 5.2 Selection of technological water solutions to reduce water demands

This task will be led by IWA. An important driver of the future of the World's water will be the efficiency at which water is used in agriculture and other water-intensive sectors. Since water stress is already prevailing in many regions, research and technological developments are underway to improve the efficiency of water use. Sectors vulnerable to changes in water availability are impacted in different ways. Therefore, sector-specific knowledge and impact assessments need to be explored to quantify those impacts. For example the electricity sector suffers most during warm, dry summers, when low flows coincide with high water temperatures, and the cooling capacity is reduced (van Vliet et al., 2012). Ecosystems are most impacted by changes in river flow, diversion of rivers by dams, upstream extractions, and by changes in water temperature and water quality. Food production is most impacted by changes in precipitation and temperature, which directly affect rain-fed crop growing conditions and yields, and through changes in water availability for irrigation. Higher food prices are likely to foster accelerated deployment of existing more efficient irrigation techniques (such as low-cost drip irrigation) and development of new ones. Another range of options may emerge from agronomy, i.e. increasing water use efficiency (and thus irrigation efficiency) of plants by breeding new cultivars with higher evapotranspiration efficiency, or better heat and drought tolerance.

Task 5.3 Policy, institutional and behavioral change options for implementation of water management solutions

This task will be led by Claudia Pahl-Wostl (USF/IIASA). It will explore global trends in water governance (e.g. human rights to water, water security as guiding principle) and different governance arrangements to be potentially implemented at national level. Governance arrangements include sets of governance options (e.g. regulatory frameworks; economic approaches such as water pricing, water markets, or payments for ecosystem services; participatory irrigation management). Appropriate bundles of measures and solution options will be defined that take into consideration the influence of the specific socio-economic, political and cultural context in a region/basin and scenario narrative.

Task 5.4 Guidance for implementation/testing of water solution options in simulation models

There is a need for guidance to assist the different participating WFaS modeling teams (in WP2 to WP6) in scenario implementation, harmonization of numerical assumptions and model parameterization needed to adequately include and test the proposed solution options in model simulation experiments. The WFaS Secretariat will appoint an experienced lead author to liaise with SAG/SFG experts and the Project Group to develop timely guidance materials for model implementation of solutions elaborated in Task 5.1 to 5.3.

Task 5.5 Impacts of scenarios on human well-being and freshwater ecosystems health

Several of the outcome dimensions represented in the project conceptual framework are not directly computed by available integrated assessment models and global hydrological models. In particular the impact of different dimensions and water stressors related to human well-being and freshwater ecosystem health need to be further analyzed in a quantitative way. This task will explore different functional relationships to quantify, where possible, the critical dimensions of water scenarios that are not a directly available as outputs from the models used in WP2, WP3 and WP4.

Task 5.6 Closing the gaps: Development of a water-focused simplified integrated assessment tool

Using the common knowledge base of sector and cross-sector analyses (WP2), multi-model water assessments and derived reduced-form technical relationships (WP3 and WP4), this Task will develop a tool for rapid integrated water systems assessment for the given range of scenarios and policy options. This tool will quantify in space and time the availability and use of different water sources and estimating the economic, environmental and social impacts of water imbalances. This integrated water scenario evaluation tool will be operated at IIASA and will provide rapid interpretations and decision support to the stakeholder and advisory groups. It will be responsive to the guidance and solution options proposed in the stakeholder dialogue. While achieving flexibility and responsiveness with respect to the requirements of the stakeholder dialogue, the tool will ensure overall consistency and methodological rigor of scenario evaluation.

As a physical backbone, such integration methodology requires accounting of water supply, use and flows at major river basin scale. It must be responsive to alternative (bottom-up) technological options and adaptation measures proposed to mitigate water scarcity and resolve water gaps, and be sensitive to alternative governance mechanisms when computing water allocation. For consistency and coherence, the methodology being applied at the global level should be scalable and equally applicable to the conditions and water sector issues of relevance in regional case studies.

The water scenario development includes a global spatially explicit analysis of water demand and water resources. Confronting water demand and water supply reveals areas of water stress and resilience of supply, providing a key input for uncovering solutions at the appropriate scale (Figure 5.3). Spatially detailed information will highlight hot spots of water vulnerability and will allow stakeholders and practitioners to test alternative water allocation principles and mechanisms.

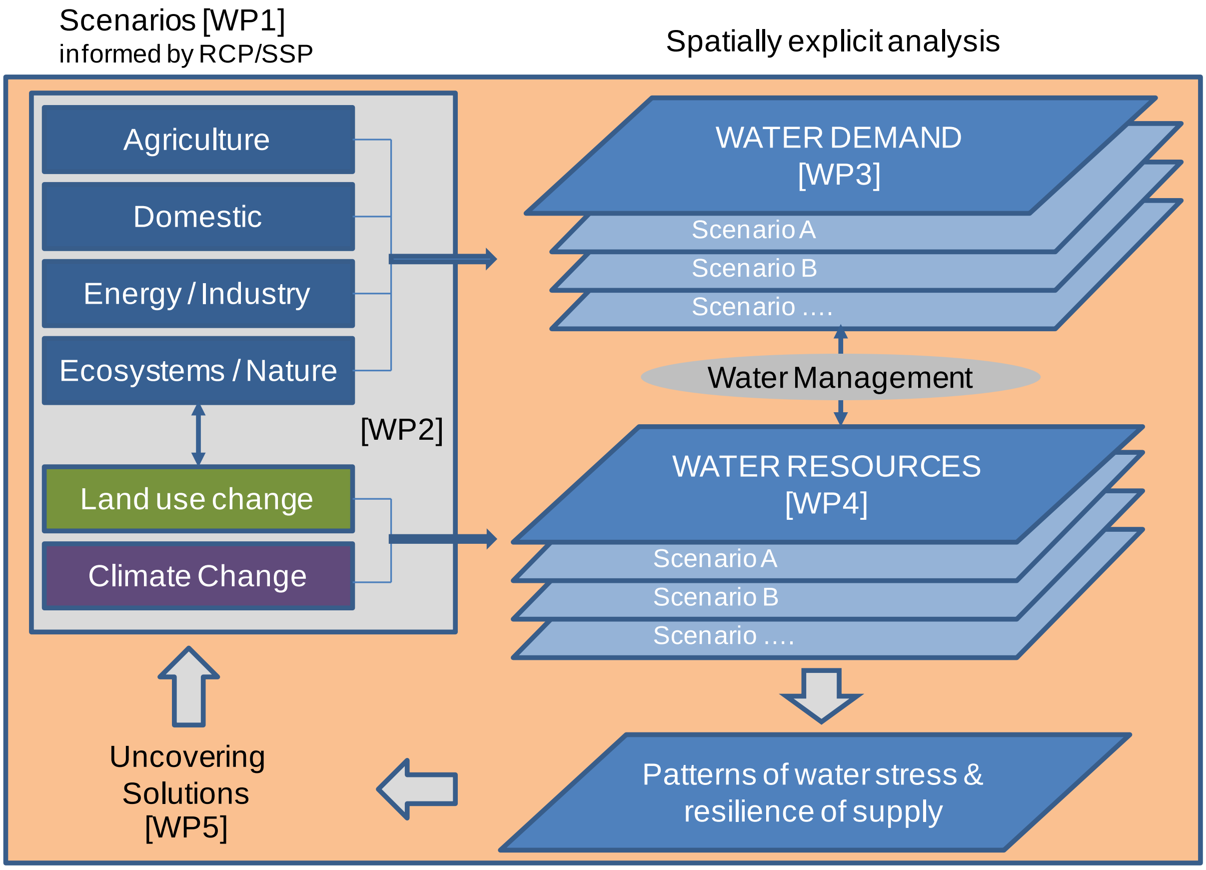

Figure 5.3: Spatially detailed analysis of water futures and solutions

Task 5.7 Water-Food-Energy-Ecosystem nexus

Land, energy and water are our most precious resources, but the manner and extent to which they are exploited is contributing to climate change. At the same time the systems that provide these resources are themselves highly vulnerable to changes in climate. Efficient management of these resources is therefore of great importance, both to mitigate the effects of climate change and to deal with its consequences (Howells et al., 2013).

These resources are also an integral part of the development challenge. Close to one billion people are undernourished and another billion are malnourished. Some 1.2 billion people live in areas where there is physical water shortage, a number which is expected to grow in coming decades. A further 1.6 billion people suffer from economic water shortages, where the infrastructure to deliver clean water is not in place. Energy access is also far from universal with 1.3 billion people living without access to electricity and 2.7 billion with no access to modern and healthy forms of cooking. If development is to take place in a broad, equitable, sound and sustainable manner, clever policy and large investments are needed, in order to ensure safe, reliable and affordable access to these essential resources (Howells et al., 2013).

This Task will focus, by region/basin and for different scenarios, on the quantification of the future developments of the so-called "water-food-energy-ecosystem nexus", which refers to the complex linkages among water availability, food provision, energy provision, and ecosystem health. Of particular interest to the WFaS Initiative is the question of how water constraints in different climate change and socio-economic scenarios will affect food production, electricity production, access to water, and ecosystem health, all of which are key indicators shaping human well-being. For this purpose we will use results of the rapid integrated water assessment in Task 5.5 and related indicators generated in the models used in WP2, WP3 and WP4.

Key Deliverables of WP5

- D5.1 (December 2013 – draft by mid of 2013) Document describing technological options for implementation of water solutions.

- D5.2 (December 2013 – draft by mid of 2013) Document describing policy and institutional options for implementation of water management solutions.
- D5.3 (December 2013) Guidance document for implementing solution options in simulation models (WFaS Secretariat to appoint lead author. Rick Connor?).
- D5.4 (December 2014 – draft by June 2014) Water-focused flexible integrated assessment tool.
- D5.5 (December 2014) Database of quantified critical outcomes dimensions representing human well-being and freshwater ecosystems health.
- D5.6 (WWF 2015 Korea – draft by end of 2014) Document/chapter presenting critical regions where cross-sectoral conflicts for water (including ecosystem requirements) may become major constraints for development.
- D5.7 (by WWF 2015 Korea – draft by end of 2014) Document presenting solution strategies to deal with the major water challenges under future climate change and anticipated socio-economic development.

Milestones

- M5.1 (October 2013) Solution options identified by SAG/SFG panels
- M5.2 (October 2013) Availability of SAG/SFG guidance for model implementation of water solution options
- M5.3 (December 2014) Availability of WFaS data warehouse and flexible integrated assessment tool.

WP6: Case studies

WP lead: (to be determined)

Objectives of WP6

- Support WFaS regional/national case studies.
- Synthesis of WFaS regional/national case studies

A global quantitative assessment of water futures is essential in view of the increasing importance of global drivers such as climate change and economic globalization. Yet, the global analysis may be restricted by data availability (e.g., groundwater resources, water quality), may not be able to cover all water-relevant aspects (e.g., water use in tourism, geo-political conflicts) or may lack the level of detail to capture local solution options.

The WFaS Initiative therefore plans to complement its global analysis with regional case studies. Case studies will be selected to be representative for different biophysical and socio-economic settings. Regional case studies will closely interact with the global analysis by informing the stakeholder groups in the process of scenario development, by mutually exchanging data and results as required for the global and regional analysis, and by aiming towards an integrated set of robust solutions applicable for a wide range of water management conditions.

Selection criteria for case study identification may include (i) the relevance and representativeness of water-related issues to be analyzed in a case study, (ii) availability of resources to undertake a case study, and (iii) barriers/limitations that may prevent timely participation. The different regional case studies shall be chosen to represent different biophysical conditions and/or different aspects of the water-food-energy-ecosystem nexus. The selected case studies must be well defined, must have funding available, must be sufficiently advanced to deliver results within the WFaS time frame, and be available to interact with the WFaS global analysis team.

During the whole process, the WFaS Initiative will support selected sub-global initiatives that are representative of different biophysical conditions and socio-economic settings. These could then be taken into account in refining the global scenarios and modeling them. For instance, the delineation of agricultural areas by farming systems, by development level and by agro-ecological zones provides a suitable device to cluster options and uncover solutions for agricultural water management. Time and resources permitting, a typology could thus be developed of situations or classes of countries sharing common issues to assess scenario boundary conditions during the later survey exercise we will conduct with representative actors and decision-makers. These typologies will then lead to the identification of combinations of options that are effective and robust under the conditions faced.

Task 6.1 Case study 1
Task 6.2 Case study 2

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Task 6.n Case study n

Key Deliverables

- D6.1 (month XX) Document presenting case study synthesis.
- D6.n (month XX) Case study reports.

Milestones

- M6.1 (month XX) XXX

WP7: Coordination, communication and dissemination

WP lead: WFaS Secretariat

Objectives of WP7

- Oversee the preparation of the project process and financing plans and monitor their implementation
- Provide technical collaboration infrastructure and means of communication
- Plan and organize dissemination of WFaS products and findings and funnel feedback to the Project Group

Coordination, communication and dissemination activities of the WFaS Initiative are bundled in WP7. One task deals with project management, coordinating modeling activities among different work packages in accordance with the project plan, with organization of the SAG, SFG and Project Group meetings. A related task in WP7 will be to facilitate and implement communication channels within the Initiative via online collaboration tools. A third task will be to make the water scenarios and outcomes of the WFaS Initiative publicly available as they are developed via online portals, scientific publications and policy briefs, websites, databases and toolboxes. Communications will take advantage of any other technologies and opportunities that can help disseminate the ongoing work and scenario results, findings and recommendations for solution strategies and funnel feedback to the Project Group.

Task 7.1 Coordination, planning and tracking of activities

The project plan will be prepared in coordination with the task managers in the Project Group and entered into a project management system (PMS) that will track the responsibilities, timing and resources used in carrying out Tasks 1-7. As the Initiative progresses the Secretariat will adjust the project plan taking account of progress in implementation and available funding as reported in the PMS.

Coordination, planning and tracking of activities includes a number of responsibilities including: preparing, revising, and monitoring the work program; ensuring respect for timetable and budget; drafting and updating project documents, partnership agreements, and terms of reference; collecting, organizing, maintaining, and archiving project information and documentation; organizing and managing project outputs and activities; coordinating and facilitating communication among members of Governing Board, Scenario Focus Group and Sector Actors Group; convening and organizing project meetings; creating and updating the project's public presence and outreach activities; and facilitating administrative arrangements. A variety of tools will be employed including project management software and internet-based collaboration tools (webpages, discussion boards, file and data sharing interfaces) developed in coordination with Task 7.3.

Task 7.2 Fundraising and budget management

A budget will be prepared for the Initiative based on estimates provided by the managers for each of the Tasks 1-7 and submitted to the Governing Board for approval. Work packages will be identified for funding and circulated to potential donors by the Initiative's partners and Governing Board members with coordination by the secretariat. The financing plan will be entered into the PMS as a budget for each Task and monitored to ensure compliance.

Task 7.3 Data warehouse and decision support system (DSS) architecture and implementation

Data warehouse will provide the data infrastructure supporting collaboration of multi-disciplinary teams working at distant locations. It will provide a DBMS (database management system)-based data warehouse for sharing databases and modeling results, as well as web-services for managing data exchange within collaborative modeling processes, both built on the SMT (Structured Modeling Technology) developed and tested at IIASA. A key requirement is to assure consistency of data and results of various models, which will be managed by designing and implementing a common SMS (Symbolic Model Specification). Another challenge is to support harmonization of multi-model analysis. A logically correct and efficient organization of the work-flows will be researched and defined.

Task 7.4 Means and modes of communication among Initiative partners

Stakeholder consultation processes across different sectors and multidisciplinary projects are built upon effective communication, both within the Initiative and between the Initiative and the outside world. Also, the Initiative cannot be relevant or useful unless the knowledge brought together and produced by the Initiative can be made available and used for better decision making in water resources management. This Work Package is responsible for development and implementation of a communication strategy with feedback from the Secretariat. It will assist project members by providing information and making suggestions on good communication skills within the project, employ communications technology to assist communication within the project via online collaboration tools.

Task 7.5 WFaS dissemination strategy and products

This Task will produce a public communications strategy for the Initiative, plan for and produce materials, publications, websites, databases and toolboxes as the Initiative progresses, and take advantage of any other technologies and opportunities that help disseminate the scenarios, tools, and solutions developed by the Initiative, and collect feedback.

Key Deliverables of WP7

- D7.1 (June 2013) Project management system in place
- D7.2 a (May 8 2013 Project budget and financing plan from Launch Meeting to October 2013
- D7.2 b (October 2013) Project budget and financing plan in place (including in-kind contributions)
- D7.3 (May 2013) Project page on IIASA website (or own website?)
- D7.3 (September 2013) Online collaboration tools that provide a platform to share model experiments, results, solution options.
- D7.3D7.4 (December 2014) Online database including tentative global water scenarios under future climate change and socio-economic changes (visualization and download).
- D7.6 (March 2015) Presentation to WWF7
- D7.5D7.6 (month XX) Dissemination plan (events and products).

Milestones

- M7.1 (May 2013) WWF7

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