Integrating knowledge from computational modeling with multi-stakeholder governance: Towards more secure livelihoods through improved tools for integrated river basin management

Brief title (no more than 5 words)

Integrating Governance and Modeling

Executive summary (500 words maximum)

The objective of the proposed project is to research the use of integrated simulation models as decision-tools in multi-stakeholder negotiation processes at the sub-basin level. The proposed project sites are the Volta-Basin (Ghana) and the 'virtual' Andes basin (Melado basin, Chile), where construction of agent-based simulation models that combine economic and hydrological sub-models is already underway. The project will focus on (1) the analysis and strengthening of multi-stakeholder governance structures in the two project sites (Sub-Basin Management Board in Ghana, Water User Associations in Chile), (2) the identification of problems, policy options to address the problems, and criteria for evaluation policy options by the stakeholders, (3) the extension of simulation models to incorporate the impact of climate change on land and water use decisions of risk-averse producers, (4) the evaluation of alternative policy options, as identified by stakeholders, (5) the development of decision-support tools that present and visualize the outputs of the simulation models in a form that is useful for the stakeholders, and (6) the actual use of the decision-support tools in negotiation and planning processes in the multi-stakeholder governance structures.

Dissemination strategies will be based on the development of different formats and media targeted to different audiences, and will include: materials prepared for stakeholder workshops, a film that can be used for extension purposes, training materials for using and managing the computer simulation model, participation in regional and virtual networks (i.e. e-groups of Water for Food Challenge Program projects), policy briefs, research reports and journal articles.

Institutions participating

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Dr. Harald Kunstmann

- Meteorology
- GLOWA-VOLTA Project (His involvement is covered by the budget of the Center for Development Research ZEF).
- Research Fellow

Budget requested from CP (in US$)

USD 1,572,098

Budget offered as matching funds (in US$)

USD 493,540

Total budget (in US$)

(Please ensure that these data are consistent with the totals in your budget tables)

USD 2,065,637

Duration of project

4 years

Coverage of basins

Indicate the Benchmark Basins, Associated Basins or non-CP basins that the project covers. Indicate, by percentages, how the work is distributed among these basins. ***Important: Before preparing your proposal please read the priorities for the benchmark basins and associated basins that you have included***

- Andean river basin
- Volta basin

Coverage of themes

Crop Water Productivity Improvement (Theme 1)	0%
Multiple Use of Upper Catchments (Theme 2)	40 %
Aquatic Ecosystems and Fisheries (Theme 3)	0%
Integrated Basin Water Management Systems (Theme 4)	50 %
Global and National Food and Water System (Theme 5)	10 %

TEXT SECTION : MAXIMUM 6000 WORDS IN TOTAL . Please note that any words beyond 6000 will be deleted and not sent to the evaluation panels.

Background and justification

The management of water basins in an integrated and sustainable way is characterized by three types of complexities: (1) environmental and economic interactions which affect water availability and quality, and concomitantly, household decisions on land and water use, (2) social interactions between stakeholders who are socio-economically and culturally diverse and who often have competing interests and power relations, and (3) a constantly changing macro-environment, including climate change and population pressures, The biophysical and economic environment determines the opportunities and constraints faced by different stakeholders in securing their livelihoods, and also determines potential externalities that might arise under alternative water management systems. Social relationships shape how these constraints and externalities are managed, leading to ultimate outcomes in terms of efficiency of water use, equity in access, and

sustainability.

The main hypothesis guiding the proposed project is that river basin management can be significantly improved by (1) developing a decision-support tool for evaluating environmental-economic-social interactions that takes both scientific and local knowledge into account and that allows for assessing potential impacts from external changes, particularly climate and population change, and (2) by testing and promoting the use of the decision-support tool within multi-stakeholder governance structures.

To develop a decision-support tool that fulfill these functions, research is necessary to identify:

1) major hydrologic and agro-ecological externalities and/or constraints to agricultural production
2) households' water uses, participation in collective action, and range of risk-coping and management strategies
3) inter-relationships between users implied by different water management systems, and thus the scope for collective action
4) prevailing social relations that shape how well collective goals can be attained, and subsequently the set of institutional options necessary to ensure successful management
5) likely pressures on water management institutions in the future, given predicted changes in population densities and climate change, and potential technical/institutional responses.

The research will be conducted in the White Volta Sub-basin in Ghana and the Melado Basin in Chile. The annex provides background information on the two research areas. Our research will be embedded into pilot policy initiatives being undertaken by the Ghanaian Water Resources Commission (WRC) and the Chilean Agricultural Extension Service (INDAP), which operate programs for the development of poor communities (PRODESAL) and for upper catchments (PRODECOP-SECANO). In the White Volta Sub-Basin, the major problems identified by members of the GLOWA-Volta project are (1) increasing rainfall variability that disproportionately affects poor rural households dependent on rain-fed agriculture, (2) improved management options for allocating water resources in a sustainable way in view of externalities, increasing population density and climate variability, and (3) reconciling inconsistencies between customary institutions and procedures of water resources management with official policies (GLOWA-Volta, 2003; van Edig et al., 2002). In this region, the WRC is currently establishing a management board for integrated water resources management.; WRC explicitly requested the partner institutions (ZEF, WRI, ISSER) to supply scientific knowledge and provide an institutional analysis of the project.

In the Melado Basin, a system of water user associations and a market for water rights have already been established. The major problems in this basin are (1) the low efficiency in water use, which is in the range of only 30 % (University of Concepción, 1999), (2) the limited access of small-scale farmers to irrigation, due to low lobbying capacity and limited representation in water user associations, and (3) institutional bottlenecks in the implementation of irrigation support programs for small-farmers (PRODESAL) and people located in upper catchments (PRODECOP-SECANO). In this basin, we will collaborate with the Water Users Associations, Chilean Agriculature Extension Services (INDAP), and the NGOs working in the area. In both research sites, specific research questions will be identified in collaboration with stakeholders as defined in the Activities and Methodology section below.

Selecting two catchments at different stages of institutional and infrastructure development enables greater scope for generalizing results and understanding pathways of river basin development. Chile has been widely considered a role model for market-oriented and decentralized approaches to water resources management. Empirical research, however, indicates that the marginalization of disadvantaged user groups, especially in upper catchments, has not been overcome. In the Melado catchment, a 'typical' sub-basin of the Maule river covering some 600 km^2, there is a pronounced dualism of market-oriented large-scale holdings with fruit plantations in the valley and subsistence-oriented small-scale holdings on the uplands. On

average, 1/3 of the catchment is irrigated, but of the 4,445 'minifundista' holdings (holdings of about 2 HRB ('hectáreas riego básico')), less than 10 percent is irrigated. In contrast to the relatively wealthy farm households, income per head of minifundista households is less than 2 US$/day (University of Concepción, 1996-1999).

Ghana has recently adopted a decentralization approach to water resources management based on the principles of devolution and water pricing to overcome problems of poverty and inefficient resource use. Ghana has a population of about 18.4 million people with about 10.2 million living in the Volta basin; about 40% fall below the poverty line of 1 US$/day (GSS, 2000). So far irrigation does not play a significant role in water use. However, a substantial increase in irrigation development is anticipated. The potential irrigable area in Ghana has been estimated at 346,000 ha; currently only some 10,000 ha are irrigated. Yet, both irrigated and rain-fed agriculture will need to adapt to increased rainfall variability, which is likely to increase due to global climate changes and the impact on the hydrology cycle.

Against this background, comparing the Ghanaian and Chilean case studies offers a valuable chance to study how decision tools and governance structures can be created and maintained that ensure a sustained involvement of different stakeholder groups during the progression of river basin development, without marginalization of disadvantaged user groups. Creating these decision tools and governance structures requires a challenging interdisciplinary collaboration between the research communities dealing with the environmental/economic complexities and those dealing with the societal complexities of river basin management.

Approaches to deal with the social and institutional complexities of resource management have focused on understanding the factors affecting collective action (c.f. Ostrom, 1992; McCarthy and Dutilly-Diane, 2002), including the appropriate form of multi-stakeholder governance structures. Major methodologies used to analyze multi-stakeholder governance structures in natural resource management include action-oriented research and the analysis of different systems of property and water rights, using the concept of legal pluralism (Meinzen-Dick and Pradhan, 2002). To analyze power relations between stakeholders the concepts social and political capital have been applied (Birner and Wittmer, 2003), while the concepts of transaction costs and decision costs have been used to assess the efficiency of multi-stakeholder governance structures (Mburu and Birner, 2002).

To model the environmental and economic complexities, integrated river basin modeling has been developed to combine hydrology, soil, climate and crop models with economic models A particularly promising new development is multi-agent modeling, which explicitly depicts the interactions between resource users (the "agents") and resources used at different scales (Berger and Ringler, 2002). Multi-agent models are particularly suited for use in multi-stakeholder planning processes, because they make it possible to explicitly model different stakeholders as different agents and to simulate their interaction. Such models can highlight distributional consequences of alternative management scenarios and external changes– a distinct improvement over conventional models. Finally, such models are well-suited for incorporating expected changes in the external environment, including different climate change scenarios (IPCC, 2001).

The powerful research opportunity here is the integration of different research paradigms to develop decision-tools that can be used by a wide range of stakeholders to evaluate alternative water management systems, governance structures and institutional rules in terms of distributional, efficiency and sustainability criteria, as well as capture impacts of climate change and population growth. Past experiences with multi-stakeholder governance processes have highlighted the need for better assessments of the impacts of

alternative policies or interventions for different stakeholders. Simulation models can provide these assessments, but will only be useful if stakeholders can build trust in these models, if the models allow for the exchange of scientific and local knowledge (feedback mechanisms), and if the socio-political dimension of multi-stakeholder negotiation processes is adequately taken into account (c.f. Blomquist 1992; D'Aquino et al., 2003). To avoid simulation models being used only by academics and/or technocrats, it is essential to involve the different stakeholders from the beginning of model development. This has been done, for example, by anthropologist Steven Lansing (1991) in Balinese subaks.

The primary target groups of this project are the multi-stakeholder institutions in charge of river basin management in the two study regions: the Sub-Basin Management Board of the White Volta River in Ghana and the Water Users Associations of the Melado River together with PRODESAL in Chile. Of great importance to this project is the way it builds on previous work in Chile, and is integrated into a long-term project in the Volta Basin – the GLOWA-Volta project led by ZEF (Center for Development Research), which has established strong links with local and national government agencies, and local NGOs. In both cases, we benefit by having access to a wide range of data, experience and information. The ultimate beneficiaries of the project are the people living in these river catchments, who are expected to benefit from improved water management, as well as the population in other basins to which the project results will be disseminated.

Goal

This project will contribute to the overall goal of managing land and water resources in river basins in an integrated way that is economically efficient, environmentally sustainable and socially acceptable, by increasing the understanding of the institutional structure of water management systems and by developing integrated simulation models capable of being used as decision-tools in multi-stakeholder governance systems. Models that integrate scientific and local knowledge will help quantify externalities and trade-offs between goals of economic growth, reduced vulnerability, food insecurity, environmental sustainability and equity. It is also necessary to examine long run impacts of predicted changes in climate and to evaluate alternative policies under different climate scenarios. Decision-tools based on simulation models help to identify technical, economic and institutional options that increase water productivity and reduce vulnerability to shocks and climate variability. However, selecting and implementing such policy options requires negotiation among the stakeholders concerned. Therefore, the project also aims at contributing to the design and implementation of governance structures that improve the prospects that such negotiation processes lead to efficient, equitable and environmentally sustainable outcomes.

Specific objectives

- Analyze multi-stakeholder governance structures
- Develop decision-support tools for predictive understanding of agent-agent and agent-environment interactions that integrate local and scientific knowledge
- Use of the models as decision-tools for planning processes in multi-governance structures and monitor their use

Activities and methodology

Output 1: Multi-stakeholder governance structures and processes are assessed

Activities to generate output 1 will be the primary responsibility of Regina Birner for Ghana, and Heidi Wittmer for Chile. Ruth Meinzen-Dick and Nancy McCarthy will be responsible for analyzing the wider body of relevant literature and helping to design key-informant interview protocols. Jose Diaz (Chile) and Felix Asante (Ghana) will work closely with Regina and Heidi to develop the site-sensitive research, and the Post-Doc will share responsibility for the key informant interviews in Ghana.

Activity 1.1: Compile and analyze reports from previous research

This activity will ensure that all team members have a common knowledge of past project experiences.

Activity 1.2 Collect and analyze legal and organizational information

Attention will be paid to include not only formal legal information, but also information on customary law concerning watershed management.

Activity 1.3 Conduct interviews with key informants and analyze information obtained

The analysis will be conducted both from a sociological perspective and from an institutional economics perspective combining the concepts of water rights, legal pluralism and transaction costs as well as the concepts of social and political capital, into the analysis of existing multi-governance structures. More specifically, it will identify:

1) stakeholders, including different groups of water users differentiated by socio-economic status, gender, location in the watershed; and administrators, NGOs and private sector representatives. Incentives to participate in collective action and the power relations, and representation in the basin management institutions, will also be identified.
2) institutional mechanisms and policy conditions within which stakeholders interact; the distribution and sharing of rights, responsibilities and risks between government agencies at different levels, local communities and other actors; and, decision-making procedures (deliberation, voting, etc).

Output 2: Institutional Platform for Integrating Stakeholder Knowledge Implemented

Primary responsibility for this set of activities will fall to Felix Asante and Regina Birner in Ghana, and Jose Diaz and Heidi Wittmer in Chile. Ruth Meinzen-Dick will play a strong role in Activities 2.1 – 2.3; Nancy McCarthy and Winston Andah in Activities 2.4 and 2.5. The Post-Doctoral Fellow will play a leading role in all aspects of the following activities.

Activity 2.1: Establishing a collaborative research and learning framework

Depending on the outcome of the institutional analysis, the project will identify and implement options to include stakeholders who are not yet represented in the existing governance structures. To guarantee a collaborative research and learning approach, protocols for guiding the process will be established jointly by stakeholders to specify procedures, rights and responsibilities. A process of ongoing collaborative monitoring and evaluation (see activity 4.1) will be established, ensuring that actions are followed by critical reflection. Working groups of stakeholders and researchers, established on the basis of the institutional analysis and consultations during initial stakeholder workshops, will guide the process. Since the project works with representatives of different constituencies (farmers, women's groups, etc.), special attention will be paid to the feed-back processes between the representatives and their constituencies.

Activity 2.2: Identify information needs and specify problems

Participatory methods, e.g. mapping, ranking and scoring techniques will be applied to specify problems and opportunities. The information needs of the different stakeholders regarding these problems and opportunities will be identified and refined throughout the project, primarily during stakeholder workshops.

Activity 2.3: Identifying management options and stakeholders' criteria in analyzing different options

Innovative management options as well as key economic, social and environmental criteria of the different stakeholders will be identified and refined, primarily in stakeholder workshops. Special attention will be paid to creating space for diverse stakeholder groups, which may involve separate meetings (e.g., womens' groups) prior to joint workshops.

Activities 2.2 and 2.3 will will be used as input to develop the decision-support tool.

Activity 2.4: Build local capacity in using methods and tools

Stakeholder workshops will be held to discuss and interpret simulation results, as well as developing the appropriate format (front-end, types of visualization, etc.) for presenting and communicating the model results. The needs and perceptions of different stakeholders will be taken into account, paying special attention to gender-specific and/or culturally-specific differences amongst stakeholders. Working closely together with the modeling team, NARES members will receive "hands on" training on the operation of the simulation models. Using the model in practical planning processes is part of a collaborative learning and capacity building process, building capacity of water users and representatives, NARES partners, and the modeling team.

Activity 2.5: Apply generated knowledge in stakeholder decision-making and policy implementation

The simulation output will be used in the decision-making procedures of the Sub-basin Management Board (Volta) and the Water User Associations/INDAP (Chile). In this phase, it is important to study how the different stakeholders make use of model results, and how the availability of these results influences the negotiation processes and the position of the different stakeholders. Studying this process involves participant observation of the negotiation meetings, and an analysis of arguments used by the stakeholders in order to identify how different stakeholders use the knowledge generated by the decision-support system.

Output 3: Decision-Support Tool Developed

Development of the decision-support tools will be the primary responsibility of Thomas Berger, Jose Diaz and Winston Andah. The tools build upon a proto-type agent-based simulation model combining economic and hydrological sub-models, which has been developed and tested for the Melado-Basin in Chile, and is currently being developed for the GLOWA-Volta project in Ghana. The model will be extended to incorporate the impact of changes in climate –e.g. increased rainfall variability – on land and water use decisions of risk-averse producers (Nancy McCarthy and Thomas Berger will play lead roles in this extension). Nancy McCarthy and the Post-Doc will be primarily responsible for incorporating stakeholder knowledge and criteria into the model, and the Post-Doc will supervise the implementation of the household survey.

Activity 3.1: Build integrative database

The project will construct an integrative database to store geo-referenced data for each region.

Activity 3.2: Develop hydrology-meteorology model component

Harald Kunstman, part of the GLOWA-Volta project, and Roberto Pizzaro in Chile will work with Berger to

link the hydrological-meteorological information with the multi-agent based model.

Activity: 3.3 Conduct household survey and develop socio-economic model component

In Chile, field surveys are needed to update the model; but good quality existing data will enable us to use a stratified sampling procedure to minimize the number of surveys required. In Ghana the GLOWA-Volta project is collecting a large range of field data on household production/consumption parameters. Already concluded fieldwork need only be complemented by a short household questionnaire, focusing mainly on risk coping and management strategies.

Additionally, household surveys will include questions on the participation of households in the collective action and community networks.

Activity 3.4: Link model components and represent stakeholder knowledge in multi-agent model

In developing the multi-agent model, special care will be taken to include the criteria identified by the stakeholders (Activity 2.3). At the interface between different model components, special attention will be paid to shared variables that are joint inputs for several models. Our approach is not to fully interface all components in the system, but to concentrate on the technical integration of the most sensitive variables and those of most interest to stakeholders. Sensitivity tests will be based on the criterion of stability ranges of input and output parameters. Highly sensitive parameters will have to be tightly coupled through run-time links. Non-sensitive parameters can be loosely coupled through simple transfers of ASCII input files.

Activity 3.5: Conduct simulation experiments and analyze environmental and socio-economic impacts

Based on the management options developed by the stakeholders (Activity 2.3), a series of "what-if" scenarios will be generated to determine disaggregated impacts of these options in terms of food security, poverty levels, ecological services, and other objectives defined by the stakeholders. Similarly, a series of "what-if" scenarios based on global climate change predictions, down scaled to regional and local scales, will be generated, and potential policy interventions evaluated in light of these changes. The requirements for collective action based on an assessment of the externalities implied will also be determined. Once we have identified critical parameters and appropriate forms of technical coupling and performed sensitivity analyses (see Activity 3.4), we will design a "back end" and "front end" of our modeling system. The back end will be implemented in modular form and later maintained and updated by NARES scientists trained as an integral part of this research project (Thomas Berger, Winston Andah, Roberto Pizarro and Harald Kunstman will develop the training module). The front end will provide user interfaces for policy simulation. Extensive dialogue and feed-back with stakeholders (Activities 2.4 and 2.5) will be used to design the front end. As seen in the Gantt chart, the timing of activities 3.5 and 2.4/2.5 has been designed as an iterative process.

Output 4: Project results are disseminated

This output is the joint responsibility of all team members. The national counterparts will take special responsibility for dissemination in their countries and other countries in the region. The IFPRI team members will pay special attention to the dissemination through the CG-system.

Activity 4.1 Monitor and evaluate knowledge exchange and impact on governance

Based on the analysis of governance structures and processes (Output 1), a continuous process of collaborative monitoring and evaluation of knowledge exchange and the implementation of the model will be conducted. Attention will be paid to procedures to ensure exchange of scientific knowledge provided by the

decision-support tools and local knowledge of the stakeholders, and to establish trust in the model results. The process will be designed specifically to avoid "interest capture" of the process by some of the stakeholders. Methods include brief questionnaires of the stakeholder representative concerning their assessment of the process (e.g., at the end of stakeholder workshops), focus group interviews and participant observations of the interaction between scientists and stakeholders and among the stakeholders.

Activity 4.2: Scale up and disseminate results from stakeholder interfacing

To successfully scale up results of the project we will form a strategic alliance with key governmental and non-governmental organizations in charge of watershed management at the beginning of the project. In Volta, the WRC, which is in charge of the White Volta policy pilot, is a particularly important partner for scaling-up. In Chile, the Agricultural Extension Service is a crucial partner since PRODESAL is explicitly charged with working with poor households to develop agriculture and increase access to irrigation. NARES members from other areas will receive training in using the decision-tools. An important partner for dissemnatiation Latin America is CAZALAC (Centro del Agua para Zonas Áridas y Semiáridas de América Latina y El Caribe) UFZ has a well-established partnership with CAZALAC, which is hosted by the Universidad La Serena and operates under the umbrella of UNESCO. Other partners include the System-Wide Program on Collective Action and Property Rights, and other Water for Food Challenge Program Project Leaders; a more detailed list of partners for dissemination is given in the Dissemination section below.

Activity 4.3: Develop documentation of interfacing approach

To ensure effective up-scaling and dissemination, experiences in developing the interfacing approach will be documented for other water basin management institutions that intend to adopt this approach. Documentation includes developing a handbook/field guide and a film for extension purposes (Regina Birner, Post-Doc).

Roles of project researchers and institutions

Nancy McCarthy, an agricultural economist, has long experience with researching collective action in NRM, as well as climate risk. She has also developed methodologies for integrating qualitative and quantitative information that will be particularly useful for designing data-gathering instruments and protocal for integrating stakeholder information into the multi-agent model. Besides providing a key linking role between the fieldwork and modeling work, Dr. McCarthy will also be involved in monitoring,evaluation, and dissemination activities. Ruth Meinzen-Dick, a rural sociologist, is a world-renowned expert in governance issues and water institutions, and her expertise will be invaluable in preparing the literature review, in developing and pre-testing instruments to guide interviews with key informants and focus-groups, , and, in developing platforms for promoting information flows, stakeholder ownership and building local capacity.

Winston Andah, an hydrologist, has held a leading position in the public water administration in Ghana and has served as a lead hydrologist in a number of internationally funded water resource projects. He will play a key role in developing the hydrology-meteorology model component, developing scenarios and conducting simulation experiments, and promoting the use of the model in Ghana. In Chile, these tasks will be the responsibility of Roberto Pizarro Tapia, who is also an hydrologist. He leads the technical and scientific group in the Chilean Committee of the International Hydrology Program of UNESCO.

Felix Asante is an agricultural economist at the Institute of Statistical, Social & Economic Research of the University of Ghana, Legon. He has a wealth of experience in research on food security and will be

responsible for the analysis of governance structures, the household survey, and the interfacing of scientific and stakeholder knowledge. In Chile, José Diaz-Osario is responsible for these tasks. He is Professor of Agricultural Economics at the University of Talca/Chile. José Diaz has ample experience with applied socio-economic research and with the management of watershed management projects in Chile.

Regina Birner is an expert in the study of the political economy of institutions for natural resource management, with field experience in Latin America, Asia and Africa. Together with Felix Asante, she will be responsible for providing overall leadership and guidance to the analysis of governance structures in Ghana, and will be intimately involved in all activities involved with developing the interface between scientific and stakeholder knowledge. Heidi Wittmer, who holds a Ph.D. in rural development, has long experience in studying rural institutions in Latin America, with particular expertise in analyzing participatory structures for managing natural resources. Together with Jose Diaz, she will be responsible for leading the governance component in Chile, and in integrating scientific and stakeholder knowledge.

Thomas Berger, an agricultural economist, has been at the forefront of pioneering multi-agent based modeling, having already developed an agent-based model for the Melado Basin in Chile, and currently involved in developing the prototype model for the Volta basin. He will be leading the team in all aspects of developing simulation models for Chile and Ghana. Given his role in the greater Glowa–Volta project, he will also be responsible for forging strategic links, particularly with the hydrology-meteorology sub-components.

Outputs

Initial situation

The project will work with existing governance structures. In Ghana, the Sub-Basin Management Board is currently being established while in Chile, Water User Associations have a longer history of operation.

Output 1: Governance structures and processes are assessed:

- Conceptual framework for analyzing multi-stakeholder governance systems for integrated watershed management
- Report on governance systems for Chile and Ghana
- Policy brief on governance structures, highlighting suggested changes considered suitable before starting the collaborative model development process (e.g., inclusion of additional stakeholders)
- Journal article on comparative analysis of multi-stakeholder governance for watershed management in the two regions

Output 2: Interface of scientific and local knowledge created

- Protocols specifying the rules, rights and responsibilities of the stakeholders involved as well as the monitoring and evaluation process for developing the decision-tool.
- Summary reports on stakeholder workshops
- Report on interfacing scientific and local knowledge for Chile and Ghana, documenting (1) the criteria identified by stakeholders and the scientific criteria of the proto-type model, and (2) management options that stakeholders seek to evaluate
- Guidelines for presenting and communicating model results (front-end design and visualisation)
- Documentation of capacity of multi-stakeholder panels to use decision-support tools in their deliberation and planning processes. in both basins

Output 3: Scientific knowledge integrated

- Integrated database for geo-referenced data (GIS) for the two regions created; local capacity to manage and update integrated database developed
- Hydrology-meteorology model component
- Reports and articles based on assessment of risk coping and management mechanisms based on household survey and key informant interview; information generated to feed into simulation model
- Multi-agent simulation model developed through coupling of different model components
- Reports and articles based on simulation results, including scenarios of changes in technologies, institutional policies, and different climate change scenarios;
- Simulated results documented and visualized in appropriate form for stakeholders
- Capacity in NARES for handling and updating simulation models and decision-support tools

Ouptut 4: Dissemination of project results

- Handbook that facilitates the development of similar decision-support tools in other areas (for NARES, NGOs, etc.)
- Film that can be used for extension purposes
- Set of policy briefs disseminated to policymakers (widely defined)
- Research Report and journal articles on the use of simulation models as decision-support tools

Beneficiaries and impact

By providing a decision-support tool for integrated water management, the project will help to identify technologies and policy options for more efficient and equitable use of water resources, considering issues of sustainability in the wider context of global climate change. By establishing a framework for collaborative research and learning and by integrating the process of developing the decision-tool in existing multi-stakeholder governance structures and, the project will ensure the practical relevance and applicability of the decision-tool. On the "pathway to impact", the project covers the steps of problem appraisal, option analysis, proof-of-concept and small-scale evaluation. The project operates at a sub-basin scale. An important feature of the decision-tool is the simulation of the effects of activities at the farm-household and village scale to higher scales within the sub-basin level. The project does not include large-scale adoption, but includes measures to promote adoption at a larger scale, as noted above.

The project is expected to have the following impacts that are directly related to the CP goals:

(1) increased productivity of water resources due to a better understanding of complex interactions between land use and water availability and quantity,

(2) a socially more desirable balance of water use for agriculture and for other needs, including resource protection, due to a decision-making process that more adequately takes into account the trade-offs between different uses,

(3) improved livelihood security and reduced vulnerability to external climate events, due to better planning of water resource use,

(4) enhanced capacity of local resource users, state agencies, NARES, NGOs and other stakeholders to use scientific and local knowledge in multi-stakeholder negotiation processes, and

(5) identification and implementation of improved institutional mechanisms and policy frameworks for integrated water resources management, with special attention to the creation of space for women and disadvantaged groups in multi-stakeholder governance structures.

Impact will be achieved at different levels: On a sub-basin scale, stakeholders in the pilot sites will directly benefit from the enhanced use of scientific and local knowledge in more adaptive governance structures. The technical knowledge on integrated modeling and the development of decision-support tools can also be applied to other geographical regions, where site-specific databases are established. The experience with using model results in multi-stakeholder governance structures can also be applied to other settings. The sustainability of the use of the model as decision-tool is fostered by the emphasis on building capacity for the operation of the decision-tool (front-end & back-end) within the NARES as well as on building capacity for using the decision-tools in multi-stakeholder negotiation processes.

Assumptions and risks

1) The relevant stakeholders agree to the process of using simulation models as tools.

This risk is minimized by involving stakeholders from the beginning of the process of model development.

2) The model produces realistic results found useful by stakeholders.

Risk is minimized by the fact that a successful prototype of the model already exists for the Melado basin, the model team has a high technical capacity, and feedback mechanisms will be used to update/refine the model.

3) Capacity of NARES in handling the models can be established.

Involving NARES members as principal researchers and providing training significantly reduces this risk.

4) "Interest capture" of the model by more powerful / better-educated stakeholders can be avoided.

Analyzing and addressing the diversity of local stakeholders and their different perceptions and priorities will be explicitly integrated into the protocols for stakeholder involvement; procedures to create space for disadvantaged groups within the negotiation process and a continuous collaborative monitoring of the

process will be established.

Monitoring and evaluation plan

Monitoring and evaluation activities are built explicitly into project activities, as captured above in the Gantt chart. Detailed workplans developed at the inaugural workshops held in Chile and Ghana will refine timelines and milestones to ensure outputs are produced and identify bottlenecks early on. Workshops are scheduled each year; the first two days each meeting will be attended only by team members and dedicated to monitoring fulfillment of workplans. The next two days of the workshops will be dedicated to evaluating the quality of research outputs; a wider body of stakeholders will be invited to ensure quality peer review. The final day of the workshop will be attended by team members only, for the purposes of summarizing the workshop, reassessing future workplans, and reformulating said plans when necessary.

The framework for monitoring and evaluating knowledge exchange more specifically will be based, in part, on yearly stakeholder workshops. While stakeholders themselves will decide on the detailed framework, an assessment of the establishment of two critical information flows will be of high importance: 1) how well stakeholder information is integrated into the multi-agent simulation model, and 2) how well simulation model outputs are disseminated back to community members, in terms of the user-friendliness of output formats the ease with which stakeholders' knowledge is fed back to the model.

At the end of the second year, team members will meet at mid-term reviews in Ghana and Chile. This would be an excellent time for external reviewers to attend the meetings in Chile and Ghana. Two evaluators per cite would be ideal; one with experience in modeling, but with particular expertise in integrating stakeholder-determined scenarios into model development, and in generating innovative platforms for model --- stakeholder interfaces. The second evaluator ideally would have expertise in water resource management, particularly in identifying externalities and institutional frameworks for participation and collective action. The final workshop will be an international workshop attended by all project team members, plus a wide range of external experts, including team members from other Water Challenge Program research projects.

Given that there are seven institutions involved in this proposed research, and activities undertaken in two countries on two different continents, the key resource person for monitoring and evaluation will be the post-doctoral researcher. While the post-doc will be based in Ghana, s/he will travel to Chile at least twice a year.

Dissemination strategy

In the Volta Basin, the project will be linked to the GLOWA Volta Project and Policy Pilot of the Ghanaian Water Resources Commission. At the basin level, several new programs on integrated water resources management have been initiated (funded by Green Cross, GAF etc.). Due to its association with GLOWA-Volta, the proposed project will be embedded into well-established research and policy networks both in Ghana and other countries sharing the Volta Basin. In Chile, the project will build upon the Melado Catchment Project of the University of Talca, which has created networks with stakeholders and policymakers with whom we can work to ensure dissemination of results. The proposed project will also be linked to programs of the Chilean Extension Service (INDAP) for upper catchments (PRODECOP-SECANO)

and marginalized stakeholder groups (PRODESAL). As noted above, CAZALAC, with whom UFZ has a well-established partnership, will play a key role for disseminating project results throughout Latin America.

The project will organize stakeholder workshops and training courses and produce different types of materials for dissemination (policy briefs, handbooks, film, academic reports, etc.). For international dissemination, the CG-System will play an important role. The experience with integrated modeling and the development of decision-support tools, and the application in multi-stakeholder negotiations, will be useful for other resource sectors, such as rangeland and forest management. In this regard, the CG-System Wide Program on Collective Action and Property Rights (CAPRi) will provide an excellent network for dissemination. Finally, team members have contacted members from three other proposed CP projects to discuss plans for sharing information and disseminating both intermediate and final results. In particular, both CN 263 and CN 69 (Project Leaders: Francois Bousquet and Jose Ignacio Sanz, respectively), will be involved with integrating model development with stakeholder analysis and participation in different basins, CN 132 (Alonso Moreno) will also focus on integrating quantitative and qualitative data in a participatory framework. We intend to maintain a strong network with these projects if funded; and we are keenly interested in using the "bulletin board" idea, along with project leaders from CN's 138, 168 and 69.

Resources needed

Human resources:

Research staff

- Post-doc employed at IFPRI, for 42 months, outposted for 30 months
- 18 months of IFPRI research staff time
- Nearly 48 months of ARI research staff time, provided as matching funds. 30 months of support staff time
- 50 months of research staff time in Ghana, plus 90 months of support staff time
- In Chile, 26 months of principal investigator time, and 20 months of support staff time in Chile
- 14 months of consultant time in Chile (matching funds from GLOWA-Volta in Ghana)

Travel and accommodation

- 56 trips made by the 8 PIs, plus the Post-Doc, over 4 years to the Ghana/Chile/Germany/Washington DC (most trips to Chile/Ghana)

Equipment

Renting of

- cars for fieldwork and Post-Doc
- hydrological equipment (Chile) to construct hydrological model component (matching funds in Ghana)
- Computers and software

Consumables

- Communication (includes matching funds for film)
- Office material

- Material needed for field surveys
- Enumerators for field surveys