5. Fishing for food and food for fish
Negotiating long-term, sustainable food and water resources in a transdisciplinary research project in Burkina Faso

Gabriele Slezak, Jan Sendzimir, Raymond Ouedraogo, Paul Meulenbroek, Moumini Savadogo, Colette Kabore, Adama Oueda, Patrice Toe, Henri Zerbo and Andreas Melcher

5.1 Research context

In response to threats of chronic water scarcity and episodes of severe and long-term drought, the government of Burkina Faso started to create a widely dispersed network of water storage facilities throughout the whole country in 1950. As fisheries, these reservoirs have also become important new sources of food (Petit et al. 2009, Venot et al. 2011). However, there exist several threats to the services, e.g. fish and water quality, that these artificial aquatic sources provide (CNID-B. 2010a&b, Mahé et al. 2005). The predominant ones are overfishing, intensive agricultural activities around the water resources and the process of sedimentation. Within the framework of the Burkinabè national development programme, attaining food security and providing drinking water are central to the government's national development policies and strategies. Thus, to establish a sustainable management of natural and human-made aquatic systems, the responsible Ministry of Agriculture, Water and Fish Resources in Burkina Faso started to develop an integrative water and fish management strategy, which required methods and tools for the standardized assessment of the water quality and ecological status of rivers (MAHRH 2003, 2006).

The implementation and further development of this strategy requires personnel trained in management and the science that underpins its tools of data collection and analysis. In the framework of Austrian development

cooperation, a senior manager of capture fisheries and aquaculture at the former Ministry's General Directorate for Fish Resources (GDFR) was supervised at the University of Natural Resources and Life Sciences (BOKU) in Vienna for his Doctoral research on fisheries and water management in Burkina Faso. The main aim of this interdisciplinary work was a general assessment of fish stocks, catchments, anthropogenic impacts on water, local knowledge and ecological awareness in fishing communities. At the policy level the purpose was to outline key areas for future management policy in the fisheries sector. The field research emphasized the importance of local fishing communities' knowledge on fish and prospective fisheries in arid inland waters and showed a serious lack of data on biodiversity and on river health (Ouedraogo 2010).

5.1.1. The establishment of a transdisciplinary research project

Further support for implementation of the water and fish management strategy came from an international project on monitoring and managing sustainable fisheries and water bodies in Burkina Faso[1], SUSFISH - Sustainable Management of Water and Fish Resources in Burkina Faso. This project recognized the history of failure of development projects based only on technical and/ or scientific advances. In Burkina Faso examples of abandoned equipment and infrastructure (fishponds, refrigerators, fish-weighing scales, fish shops) to support the modernization of fisheries testify to this. Aside from a few examples of successful organization of local management capacity, for the most part, there are significant gaps between national and lower levels of governance in Burkina Faso. Briefly, a governance system that effectively functions from the central, national level out to the regional and local levels has yet to be established (Melcher et al. 2018). Often the link between laws and actual practices in the monitoring of fisheries is not based on lived practical experience. One major challenge in fact seems to be adapting legislation to everyday practice. But traditional institutions play a vital role in reaffirming the identity of communities reliant on aquatic ecosystems and thereby broadly influence water and fish management. However, as our research indicates, the current governance structure does not link and harmonize these co-created rules with national laws (Sanon et al. 2015).

1 SUSFISH - Sustainable Management of Water and Fish Resources in Burkina Faso (2011-2014) http://susfish.boku.ac.at/

This governance gap between law and practice could prove to be a key barrier to realizing the potential for fisheries to become sustainable in Burkina Faso. The principle idea was, to establish a solid basis of useful knowledge in the social as well as the natural sciences in order to assess the extent and impact of this gap. Initiatives to establish this knowledge base were jointly founded by natural scientists in academia as well as by government officials so as to explore the possibility of analyzing and then managing fisheries based on biophysical scientific evidence. A transdisciplinary and participative approach was selected in order to integrate multiple perspectives of academic, policy and local practice. But nevertheless, the whole project was designed within the framework of development cooperation and therefore the research agenda aimed to contribute scientific knowledge to the social, economic and political barriers and bridges to sustainable fisheries. The overall objective was to strengthen the institutional capacities of the Burkinabè partners in higher education, research and management. A network of natural and social scientists as well as stakeholders worked together for three years in joint fieldwork activities, workshops and policy formulation for sustainable management and monitoring strategies suitable to the environmental and political context of Burkina Faso.

5.1.2. Integrating practices of participatory research

Interdisciplinary work can reveal important cross-sectoral activities, interrelated power relations and hindering factors that play key roles in the value chain of the resource fish in Burkina Faso. However, it was necessary to understand more about the complex interconnectivities and relations of sociopolitical activities in the natural resources management sector. In addition, there was a need to integrate applied participatory research methods. Taking into account the lessons learned from the SUSFISH Consortium 2015, the project aimed to involve local actors as well as actors on the policy level in the research process. Together, they would work on questions of water management and on assessment methods based on fish in order to contribute to the analysis of processes. The inputs of local politicians and of decision makers both in the fishing communities and on a national scale were integrated in the data collection. Here, relevant data on fish, the environment and on pressures were gathered. Also an analysis of the relationship between different kinds of anthropogenic pressures, including overfishing, intensive agricultural activities around the water resources, pollution by fertilizers, manures and

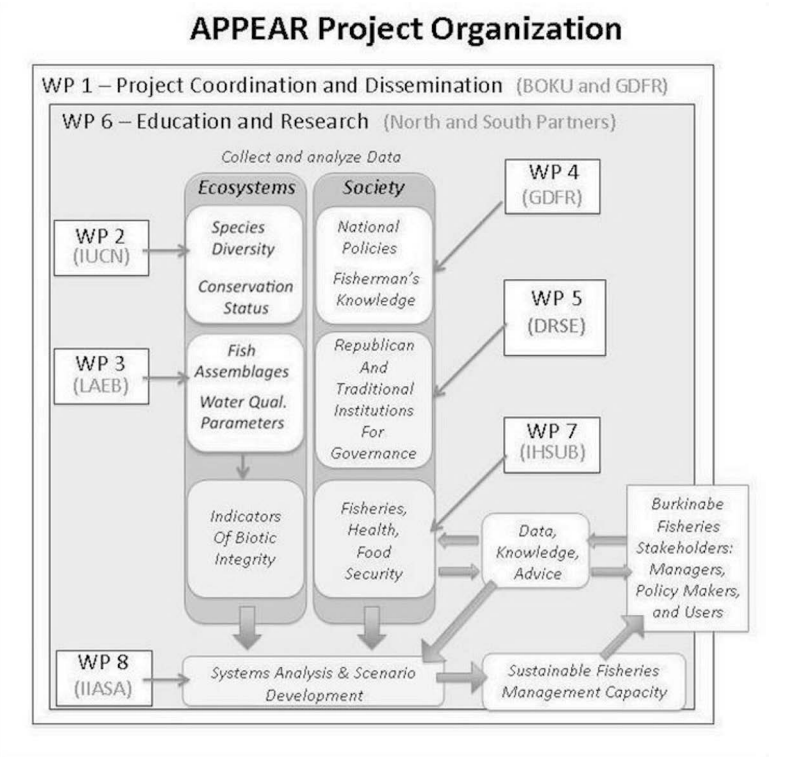
pesticides, and the dynamics in fish assemblages and in water quality were integrated in the data collection process. The concept of participatory and interdisciplinary research was manifold and focused on the following tools for cooperation:

- Joint data collection in several field trips with five traditional fishermen, doing applied research, participating in the sampling of fish, macro-invertebrates and environmental parameters
- Joint laboratory work, i.e. identification of fish and macro-invertebrates, and data analyses
- Group discussions and interviews with fishermen and women processors (fishmongers) during their regular assemblies of more than 600 sampling sites (75 waterbodies)
- Interviews with local fishermen on their ecological knowledge
- Individual and group interviews with representatives of a) the central government (general administration) and b) the local communities (locally elected people), the technical staff of rural development, the fisheries and water stakeholders in six of the thirteen administrative regions of the country
- Workshops on gender issues with decision makers in fisheries and women's organisations on a local level in all sampling areas
- Workshops and group discussions with researchers and policy makers for systematization/synthesis of results
- Two workshops with the research team for the integration of a gender sensitive approach to the research agenda. In smaller workshops the research focus was further expanded to look for interactions both within and between biophysical and non-biophysical disciplines.
- Public conferences with practitioners, decision makers and scientists. During the joint research process the overall aim was to establish a transdisciplinary knowledge basis with inputs from the natural and social sciences as well as from a diversity of non-academic experts both within and beyond Burkina Faso, such as fishmongers, fishermen, NGO representatives, business people. Open fora such as public conferences provided opportunities to evaluate and disseminate project results.

Based on research in several disciplines in the biophysical, social, economic and political areas, including the expertise of decision makers, practitioners and scientists, this project was designed as a transdisciplinary project with

several partner organizations and a large number of individuals. It was implemented by a consortium of eight organisations with expertise in the areas of research, education and development (Figure 1).

Figure 1: Sustainable Management of Water and Fish Resources in Burkina Faso (SUSFISH) project design and involved partners



The design did not consider a direct interlink between the ecosystems and society. Therefore, the method of systems analysis was introduced to the core team as a tool for integrating data resulting from more than 20 studies in various disciplines.

5.1.3. Project results

The project's ecological and biophysical research results highlighted an important diversity of fish and macro invertebrates all over the country. More than 75 fish species and 105 taxa of macro invertebrates were identified and their spatial distribution and habitat characteristics were described. This diverse fauna occupies a wide range of habitat types. Habitats are always subject to human impact, but physico-chemical parameters are in accordance with tropical areas standards. Findings gave deeper insight into reactions of aquatic species to human pressures, specifically ranking species according to their tolerance to such pressures. The presence or absence of intolerant species can be key indicators of aquatic ecosystems under pressure and thus support ecosystem management at the landscape level.

At local level, fishing practices in Burkina Faso are very heterogeneous and depend on the status of water resources. Fishing communities relay mainly on rain-fed agriculture, irrigated gardening and cattle breeding as economic activities, and fishing as an additional source of income, so fishing is mostly a part-time job for farmers and herdsmen. Case studies revealed significant historical changes in colonial times when access to fish changed allowing foreign professional fishermen to exploit fisheries at a larger scale. But there still exist institutions of local fisheries management such as guidance by spiritual leaders, rituals such as collective fishing or closing times, as case studies revealed (Ouedraogo 2010, Sanon 2015). National fisheries government varies largely according to the status of water bodies. By law there are two kinds of status of fisheries based on management type. The PHIE are "nationally important" reservoirs, thus management is organized at a professional level and most of the fishermen involved are professionals, whereas concessions are more "subsistence-level" fishing for local markets. But the large majority of reservoirs in Burkina Faso are not included in these categories, do not have a legal status and the state is barely present to monitor and sanction illegal practices. In our field data, learning fishing methods over generations contextualized in the environmental challenges was found only in a few cases. Fishing techniques include cast nets, gill nets, long lines and traps. Even detrimental and prohibited methods like small mesh size and beach seines are very commonly used.

On the governmental level, findings indicate how development projects failed due to the limited ecological awareness of local stakeholders and a lack of training for local fishermen regarding fish stock issues. This rai-

ses the question of the availability of useful and reliable information, which is essential to proper decision-making for managing water and fish resources. Local communities as end-users need to have quick access to all available data on fisheries and water resources in Burkina Faso. However, little attention is paid to the way this information was communicated, what the local knowledge was like and therefore also the participation of different kinds of stakeholders in the process of policy formulation remained unclear. At local level the fisheries department does not cooperate with local communities in managing water and fish resources and on a formal level there is a lack of natural science fisheries experts in all of the 13 administrative regions. The legislation governing fisheries is well developed but is not translated into local languages and is thus not accessible for fishermen and fish processors. There is a serious need for a platform that involves all stakeholders at all levels (micro, meso and macro) to discuss such governance issues and meaningfully influence policy formulation and implementation. Studies from Zambia gave important insights how this process of developing regulations, that are crafted bottom-up, could provide by-laws that are addressing concerns and needs of local interest groups (Haller et al. 2016, Haller et al. 2018). This need is evident where official projects are monitored without the participation of direct stakeholders, and the main stakeholders working on the management level of their associations are not trained. A higher bargaining power could be stated at the mid-level of associations where fishermen are better organized and informed and have a higher income compared to self-employed fishermen.

The SUSFISH project's surveys in biophysics demonstrated that parameters such as fish size, abundance and diversity in Burkina Faso are related to the quality of fisheries and habitat management (Melcher et al. 2012, Stranzl 2014, Kaboré et al. 2016a, Kaboré 2016, Mano 2016). By using biological indicators, it became possible to distinguish impacted and non-impacted areas and to develop a multimeric index approach to assess the ecological quality of running water bodies in Burkina Faso. Thus, the project provided a rich data basis for monitoring the presence and impacts of pressures and developed technical tools such as software analysis and hardware for fish monitoring - including training in the use of those tools standardized scientific monitoring and assessment of the ecological quality status (e.g. electro fishing, Bentho Macro Invertebrates sample protocols, rapid field assessment protocol), applied to the environmental context in Burkina Faso.

Gender relevant research activities revealed that actors involved in fisheries are organized at several different levels of the units of production and

by processing families. Men fish in groups while women are in charge of the processing. Another level of organization involves participation in provincial unions and the National Fishermen's Union of Burkina Faso. In this context, women, who - in most cases - do not fish on their own, control the area of processing. They play an important role in the exploitation of water and fish resources, because they allow not only the conservation of water resources, but also the survival and the community's reliability on fishing by developing strategies for small-scale distribution, transport and financing. For instance, women act as donors of loans for the fishermen in periods of financial distress.[2] But this predominance of women in the fish-processing domain does not translate into significant higher bargaining power regarding women's involvement in decision-making processes in administrative and legal areas of the fisheries management. Thus, the development of institutions for sustainable use of the fisheries should consider women as key stakeholders in the economics of fishery businesses.

5.1.4 Issues with the participatory approach

As previously mentioned, the long history of technically-focused natural science projects in fisheries that failed for social, economic and/or political reasons, prompted a transdisciplinary approach. This includes indigenous ecological knowledge and integrates biophysical as well as non-biophysical factors that might help (or hinder) the sustainability of fisheries in Burkina Faso (Sally et al. 2011, see also Haller and Merten 2008, 2018, Chabwela and Haller 2010 for fisheries in Zambia). Haller et al. (2016) emphasize that for a sustainable bottom-up institution building approach, local power asymmetries need to be understood as well as local knowledge needs to be incorporated (see also Berkes 1999 on this issue of scientific and local ecological knowledge and their differences and similarities). Thus, a participatory approach accesses multiple, non-academic perspectives that are vital to transdisciplinary research (Thompson Klein 2004, Haller et al. 2016).

In SUSFISH this became evident, since the nature of problems to be addressed were not per se in the field of natural science but rather in the social,

2 Our studies revealed that 82% of fishermen have already contracted loans with which to purchase fishing equipment and fishing licenses. In 88 % of cases, the loans granted by women are repaid in kind (fish) from the production.

political and institutional context and thus needed to be negotiated cooperatively by experts from both science and (political) practice. The project sustained participatory approaches by scientific experts and policy makers collaborating in workshops with local partners as local experts to develop joint strategies to communicate the results of the scientific cooperation to local communities. This involvement of local partners as experts to share and apply their knowledge was central towards a process of shared research. This, of course, is intimately linked to language, so as to contextualize the findings of the natural science research and make it more accessible and, as a consequence, more applicable in local fishing communities around Burkina Faso. In the tradition of internationally oriented, policy-relevant science, the project sustained three levels of knowledge sharing and learning activities: 1) joint fieldwork, 2) policy formulation and strategic sector development activities for fisheries and water, and 3) synthesis of research results and definition of lessons learned including important remaining questions. But important to note, within this framework there was no space reserved for the direct involvement of local groups to deal with the problem and to start a joint bottom-up process, such as concerns-oriented drafting of by-laws described for Zambia in Haller and Merten (2018) for instance. Additionally, local actors in the various fishing communities were not a homogeneous group. Besides the diversity of socio-historical contexts, their knowledge is linked not only to French, but to local languages such as Jula and Moore as well, which were very important linguistic resources for interaction and joint discussions.

5.1.5. Fieldwork - practice and training

In order to elicit and share knowledge, interactions during fieldwork activities between scientists, policy makers, local decision makers and practitioners in the fishing sector were continuously encouraged. They started in the beginning of the project and were continued during the whole time and have been mainly conducted by a large group of students participating in the research. Developing an innovative and likewise adaptive assessment of the integrity and long-term sustainability of water quality and fisheries in Burkina Faso required intensive fieldwork for sampling and data collection. Within the project's framework of capacity building in higher education[3], a large number

3 APPEAR is a programme of the Austrian Development Cooperation (ADC) to support higher education and research for development on an academic institutional level in

of Burkinabè and Austrian students carried out most of the data collection. During their participation in several field trips for joint collection of data, students learned to work in teams together with junior and senior researchers in different study areas all over the country. Subsequently they continued the work independently. These joint excursions and field trips were designed, organized and implemented particularly with the participation of practitioners.

For instance, the 21 study areas were selected by the students' supervising scientists in collaboration with government officials. Besides biophysical and ecological criteria it was important to take into account the local management practices influencing the condition of water bodies and fish stock. Therefore, students conducting their field research were assisted additionally by supervising staff, which included traditional local fishermen, local government officials of both the republican and traditional systems and representatives of women's associations. This assistance by local experts happened either while participating in the sampling of fish, macro-invertebrates and environmental parameters, or during ethnographic fieldwork such as participant observation, interviewing and group discussions. Local experts were selected on the basis of professional experience (e.g. fishing techniques, years of training), access to local and state institutions, ecological knowledge and personal availability for the series of field trips. The local fishermen more and more shaped the fieldwork practice. Although every student followed her or his individual research focus, the project staff organized joint workshops on fieldwork methodology (within their disciplines as well as interdisciplinary).

In terms of training in ecological and biodiversity approaches, scholars at various levels of their academic career (BA, MA and PhD) were trained in seminars and in the field to undertake surveys of fish and benthic macro-invertebrates. Nine study areas all over the country were visited together during four sampling campaigns. Joint activities involved students in developing and adopting standardized field collection techniques, species identification and enumeration methods, as well as in analyses using aggregated biological attributes or quantification of key species. For instance, in the beginning it was necessary to develop a joint fishing technique, which provided a standardized

---

the ADC's southern priority countries and key regions and in three priority countries of the South Caucasus and Black Sea Region. It provides funding for academic partnerships between higher education and research institutions in the addressed countries and Austria. https://appear.at/en/

method for sampling in the heterogeneous landscape of Burkina Faso's water bodies. The best way how to negotiate and ultimately, agree was a joint training of the whole group. The outcome was a threefold method, which was oriented towards local experience in fishing: every site (segment) was sampled by electrofishing, traditional fishing methods (cast and gill nets, active and passive fishing) and fishing for benthos. Even the frequency and extent of sampling in the individual areas had to be negotiated, as it was not the goal to fish as much as possible, but to get a random result. It was important to use the appropriate fishing method for the investigated water bodies to get meaningful and consistent results on diversity and abundances. But this approach was challenging also in terms of communication: after one month of working together the students started to realize that communication was crucial to this process and that knowledge not only culturally evolved but exists as knowledge-practice-beliefs complexes embedded in their institutional contexts. It was an important experience for them to learn about alternative knowledge and perspectives based on own locally developed practices of resource use (Berkes 1999, Haller et al. 2018). Translation should not stick to a word-by-word transfer, but rather to translate concepts such as for instance that of understanding biodiversity. This is well illustrated in the following example from a cast net (Figure 2) event described in the research diary section below by Paul Meulenbroek on 12.12.2012 in the catchment of Nazinga:

> "During our fieldwork, electrofishing and cast net fishing were approximately conducted the same time frame and both methods captured around 9,000 specimen, 18 species were only caught with electrofishing and 11 exclusively with cast net. For the latter experienced fishermen are needed to perform effective fishing. The most impressive demonstration of the professional fisherman Noufou Bonkoungou's fishing experience was performed in the protected area of Nazinga. First, he walked along the river for about 10 minutes, suddenly he stopped to wait without any motions for another 5 minutes and starred at the water. Unexpectedly he started to run and throw his cast net. He could catch more than 700 specimens with one throw. In comparison, it took the students 3 hours to get one single fish. It was a very important experience for students, how to evaluate local knowledge, which is often implicit and not considered by the scientific experts sufficiently as data for their analysis."

Furthermore, the whole group worked with standardized field protocols drawn from European and international research experience. Because of

Figure 2: Electrofishing and cast net fishing. Picture: Paul Meulenbroek

fishermen's input, the participants realized during the sampling phase that they needed to change the standardized tool by integrating new parameters such as abiotic factors (e.g. extensive farming practice) in order to adapt fish and invertebrate habitat assessment protocols to the conditions in Burkina Faso. It was important to take into account many country specific factors such as intermittent rivers, mainly man-made waterbodies or a country specific velocity of rivers. A specific challenge for the team was the development of a classification tool for temporary streams, as they dry out during the hot

season. Due to the participation of local fishermen, the selection process of segments of reservoirs for sampling considered local ecological knowledge. This ongoing process of recognition of "non-scientific" knowledge systems lasted for several months and integrated the inputs of local experts such as the fishermen, local authorities of the traditional government and representatives of fishermen's associations, who all contributed their experience on seasonality of the water body and fish migration practices. It created a zone of learning and understanding on both sides, among the scientists and the local actors. Comparable to other areas a solid basis of trust was created, which invited on local level to participate, share and co-create in research activities (Haller et al. 2016: 82).

Here it is important to note that this kind of interaction was only possible because members of the scientific team could make local knowledge accessible through linguistic translation. Because of their linguistic background and their academic education, they were able to interpret this local knowledge into scientific parameters understandable to the whole team.

Local knowledge was better integrated with international science by performing different stages of data collection, processing and analysis jointly in the field. Fieldwork was embedded in joint activities to prepare specimens and process data after collection, such as laboratory work to identify and control quality for fish and benthic-invertebrates taxonomy. As local fishermen were also directly involved in these accompanying measures, the description and classification of fish species happened *in situ* at the sampling sites. Activities on sites were documented in field protocols and diaries in order to link results to workshops on the utilization of Red List criteria and categories[4]. Finally, the local knowledge on how to interpret features and characteristics of fish contributed significantly to the evaluation of the conservation status of fish species at national level. These workshops did not take place in the field but in a scientific environment framed by academic expertise. It would have been an important contribution to the evaluation process if we had considered local fishermen's expertise also at this level of research activities. Our internalized division between science and local ecological knowledge did not

4 An official list of fish species and invertebrates and a national database of metainformation on existing biophysical characteristics of fisheries, the diversity and conservation status of fish species and benthic invertebrates, the pressures on fish populations and methods of water assessment based on fish and macro invertebrates was developed during project time.

allow the imagination of the importance of such a contribution. But by reflecting this collaborative process at a later stage, we addressed the excluding effect of drawing on our existing constructions of the field, informant and science (see Foucault 1981).

Second, it clearly showed the limits of imagination of transdisciplinary fieldwork. The trips were planned along disciplinary boundaries. The focus was on ecological and biological data collection and therefore students trained in participant observation and interviewing techniques were not involved. All these important reciprocal processes of knowledge co-creation should have been elicited and processed with socio-anthropological methods of qualitative research for a better understanding of specific institutions governing the use of fisheries, such as the notion of spiritual ownership of water bodies or rules and regulations originating from pre-colonial times (see also Haller and Merten 2010).

In terms of training in socio-political approaches, students worked on issues of fisheries management, governance, society and local fishing as well as fish processing practices within the larger framework of the institutional cooperation of several university departments and the national government. Joint training workshops on research practice exposed them in two stages to transdisciplinary and explorative approaches in social, economic and political science: first, by developing a set of quantitative and qualitative data collection methods, and second, by subsequently coordinating and adjusting data analysis to the team's focal research interests.

Experts from various academic and political organizations (project team members, Work Package leaders or supervisors) provided flexible supervision in accordance with the particular implications and dynamics of the applied participatory approach. Gender expertise, for example, was integrated in the research agenda by workshops for junior and senior scientists. This included training for students on gender sensitive field collection techniques, such as methods for identifying factors for gender imbalances, implementation of participatory and awareness raising strategies in fieldwork as well as on focusing on gender issues in data analyses. The expert's long-term practical experience working with women's organizations provided methodological knowledge of how to include women into the research process although they are not represented by associations or in decision-making. In addition to these workshops, during their research she continuously reviewed their written materials e.g. questionnaires, results and reports, which she shared as part of group discussions in joint meetings. This enhanced the students' critical

self-reflection of their own research practice and of the scientific paradigm they were working in. They became more sensitive for power relations and questions of equality in the research process and reflected their own role as researchers. They had to think about their expectations in the collaboration with local actors. As a result, the field studies provided by these students feature an outstanding interest on gender issues in fisheries, nutrition, health and natural resource management, which contributed generally to applied gender research in Burkina Faso.

To conclude with an example, it was an important contribution of the government's gender expert to share her knowledge on key issues on socio-economic aspects in the water and fisheries management with the students. As a team member she was able to bring in her experience and thus improve research findings. Her contribution included taking into account gender sensitive factors for the composition of focus groups or issues of female representation on family and community level; a critical revision of questionnaires and data in terms of economic responsibilities of women in fishing communities; considering the neglect of female actors in the fisheries on policy level.

Gender sensitive studies revealed that female actors play an important economic role in the exploitation of water resources, because they support not only the conservation of water resources, but also the community's survival and their reliance on fishing. In addition to carrying out their activities, women transformed themselves into donors of loans to the fishermen, who in fact monopolize the commercial fish trade. As a consequence, women are economically important stakeholders in fisheries, but structurally excluded from decision-making processes. Findings showed that women's involvement in fisheries helps improve both diet quality and, especially, households' food security during the year.

5.1.6. Involvement of policy makers - key questions of management

Second, participation happened at local[5] and regional levels during the process of policy formulation for fisheries and water management in the context of workshops and meetings with representatives of water authorities, fishermen's associations and local governments. Three experts of the GDFR (Minis-

5 At local level, officials involved in the implementation of national policies and strategies for fisheries management in Banfora, Tiéfora, Cascades and Moussodougou have been included.

try of Animal and Water Resources Management), who were part of the project team, guided this process, which should lead to a new strategic orientation of the Burkinabè fisheries sector.

In these workshops and meetings, it was their aim to link ongoing research findings to the level of government's interaction with local and regional officials, technicians and representatives, who were in charge of training local fishing communities. In a reciprocal process, the local and regional perspectives should help to improve government policy. The interactions were therefore not limited to data collection. In field surveys the constant contact with the various actors sometimes questioned the research methods and experiences and required adjustments. For example, at the beginning of the study we did not include the local agricultural officers. This group has been suggested by the manager of the fisheries and was later integrated. Fishermen and fishmongers mainly organized the meetings of focus groups. They mobilized themselves and determined the appropriate period of time to bring the group together.

To illustrate how this interaction happened, we refer again to gender issues in the fisheries and water management policy as an example. In 2007, the General Directorate for Fish Resources of the Ministry of Animal and Fish Resources in Burkina Faso assigned a water engineer and gender expert to assess female representation and gender imbalances in the fisheries and water sector. Her work continued in the framework of the SUSFISH project focusing on the set up of a process of policy formulation. At the end of the project, a final draft of a „Stratégie d'intégration du genre à la politique de développement et de gestion durable dela pêche au Burkina Faso" was adopted by the Ministry.

First of all, this participatory approach required the facilitation of communication within the multinational team of researchers and practitioners. Secondly, in order to reflect on the input of local experts regarding fish stock, natural diversity and fishing her team members had to develop a joint strategy not only to communicate the results of the scientific cooperation to local people, but also to involve them as experts in the setting. To lower the risk that her team acted in ways that are alien and incomprehensible to local people's life worlds, unmediated interactions with local actors were organized by local technicians in local languages. In the framework of government's campaigns and technical training workshops all over the country data collection were organized with practitioners such as technicians in the fisheries, aquaculture and in water management. Their knowledge should influence the findings

of the natural sciences research. The ministerial expert monitored these interactions in separate trainings and evaluation meetings based on a gender sensitive approach. She helped them to take into account the main barriers for women to access local resources, written information or legal rights. A further topic was how to work interactively with women in male-dominated surroundings and that group composition for instance can influence if women will take the opportunity to speak for themselves. It was a major objective to achieve a deeper understanding of complex underlying processes and correlations in socioeconomic and "socio-ecologic" systems through this specific involvement of local experts of the fisheries and water management policy.

5.1.7. Synthesis of research results

During its final year the project tested ways on how to integrate scientific research in policy making and broaden the knowledge base by incorporating the perspectives of people acting in different sectors at different levels of society, from local to regional to national. This meant expanding the scope of research and policy discussion beyond interdisciplinarity (social scientists, biologists, fish ecologists and nutritionists) to include inputs from outside academia: managers (fisheries planners, policy makers) and practitioners (fishermen, fishmongers, traders) at the local and regional level. The main aim was a synthesis of all findings for final reporting and to develop key research questions for further projects. As a follow-up it was planned to formulate policy briefs for the government of Burkina Faso.

For this part of the research process, a member of the consortium provided expertise in innovative methods of systems analysis. The method was introduced to the core team as a tool for integrating data resulting from more than 20 studies in various disciplines. In two series of workshops in November 2013 and July 2014, the process assembled a diverse focus group consisting of academics and government members, who collaborated in the design and running of an experiment in scenario development (Sendzimir et al. 2011, Ouedraogo et al. 2014). Tools such as scenario development and system analysis were applied in workshops and modeling sessions. Time constraints often deny policy makers and stakeholders extended opportunities to explore the future. Therefore, the challenge for all members was to do so in a very short time period. This was done by defining the variables and their relationships that may influence future development pathways for fisheries in Burkina Faso. This exercise developed scenarios as ways for experts and partners

to examine the dynamic implications of the facts and questions generated by the project. Such exercises allowed participants for the first time to bring together, discuss and reconsider their assumptions and questions in light of the dynamics that they anticipated. It further allowed an elaboration of what particular variables and parameters ought to be measured in order to better understand how the socio-political and ecological system is changing. In order to understand the phenomenon of water and fish resource management in Burkina Faso holistically, we developed, changed, and jointly adapted our concept in an open-ended process. In terms of research practice, this was very challenging to organisation, communication, and integration of heterogeneous types of knowledge, as explained in the following.

Challenge of a complex process: The process of conceptual mapping exercises consists of several steps. It starts with the telling of a story as well as the formulation of hypotheses and key questions and continues with the ranking of the influencing parameters. In our workshops the joint examination of possible structures of relations that might underlie the dynamics opened up space for debates. These efforts were intentional and helped us to identify how some partners imagine concepts or patterns of relations and how they would propose to analyze them in the future. But it became evident that it is a challenge to examine phenomena through the broader lenses of inter- and transdisciplinarity. Frequently we found that it requires patience, trust and encouragement to embrace the complexity of problems. This means resisting the historical dependence on explaining problems by means of single, key variables and sustaining our mutual examination of the dimensions of that complexity, arriving at more nuanced understanding of multiple causation. We learned to deal with the complexity of differences but also to consider their scope of negotiation (Bhabha 2000). The process of ranking parameters, for instance, follows a linear structure that requires defining which parameter comes first and therefore has more analytical weight than another.

Challenge of disciplinary boundaries and epistemology: At the beginning of the project the differences that distinguish how each discipline focuses its research were evident to team members. During the first half of the project, these distinctions defined how we worked and were followed more or less separately. On a technical level, the project design included reporting and exchange of information for monitoring and evaluation but did not integrate a deeper understanding and learning process transdisciplinarily in all research activities. This latter reflexive process was limited to some few workshop and fieldwork contexts (Figure 3), as mentioned above, where room for dialo-

Figure 3: Workshop on systems analysis in Ouagadougou, June 2014

Thinking and reflecting in a group of up to 20 participants means to open up the floor to many, often diverging, interpretations of the specific parameters. Therefore, it was sometimes difficult for us to find a compromise for defining parameters. However, on the other hand this participatory method enhanced our ability to reflect on how we mutually collaborate to share and combine our understanding and follow correlations to define future research and policy.

gue and exchange was provided selectively. The final group discussions on our project results issuing from natural and social sciences views as well as from a diversity of non-academic sources were intensive and not always smooth because of disruptions, rejections, misunderstandings, and ideologically loaded conflicts. However, overall, we experienced ourselves as part of a transdisciplinary team with complementary bodies of knowledge and ways of knowing, - lay, local, and indigenous expertise full of contradictions, which do not lead to simplification.

Challenge of flow of knowledge and information: Our project's goal was to explore ideas that are risky because their implications lie so far into the future that prediction becomes impossible. To this end the process assembled a focus group comprising a diversity of academics and government members with the purpose to apply forecasting and back-casting techniques (Kok et al.

2011), wherein we developed various scenarios in different development exercises. These included extended discussions and controversial negotiations on definitions of sustainability, governance, subsistence and gender concepts between the involved experts (see Bourdieu 1996). The exercises provided a problem-oriented framework that invited creative ways of thinking. Consequently, it enabled a team of experts to enhance their own understanding of how they saw problems and contexts as well as how other stakeholders did. In this way the negotiation process brought even more complexity to light in a way useful to the network working on these problems. By sharing knowledge and understanding as a group we developed a collaborative knowledge base that had not been established yet.

For practical reasons this collaborative process did not involve all of the other actors engaged at earlier stages of the research. Even the group of students, who played a significant role in data collection and processing, were not included in the team. As outlined above, types of knowledge were elicited and negotiated at various steps of the research process. It would have been very important for the core team to ensure that it could become integrated in this last step of comprehensive synthesis, as we dealt with a very heterogeneous group of participants and various forms of knowledge. In fact, we, as members of the core team, became important bearers of knowledge, but were not fully aware of its importance and struggled to bring together the perspectives of diverse stakeholders, especially policy makers, local authorities and practitioners. Referring to the project's approach, the knowledge integrating process in its complexity was clearly underestimated. The various scenarios developed did identify many potential barriers to making fisheries sustainable, such as de facto open-access to fisheries, increasing pressure through agriculture and mining practices, disruption of fish migration by dams, dysfunctional government institutions because of lack of state financial support for monitoring and sanctioning, the policy focus on a few large reservoirs of „national economic interest" (Melcher et al. 2018: 530), and very heterogeneous local communities in terms of internal power distribution, few interaction in dealing with outside actors and little bargaining power as well as top-down developed law and practices to monitor fisheries.

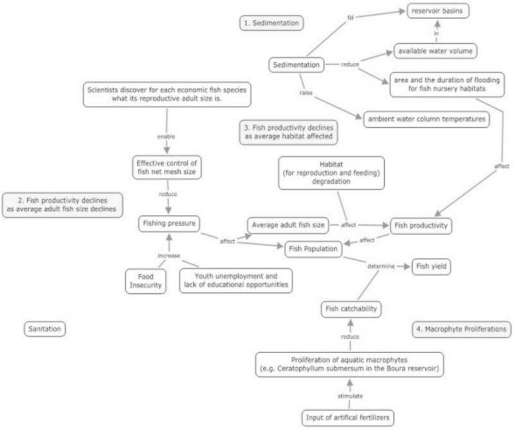
However, it would have been a significant addition to the project to rigorously identify how to exploit opportunities and circumvent challenges over the next 20 years in order to successfully establish fisheries science and management in Burkina Faso. Not only scientific and political representatives, but also students and other local actors such as fishermen or fishmongers

should have been part of the debate. These tasks clearly belong at the top of any future research agenda for Burkinabè fisheries and water management.

Challenge of time: There was insufficient time to sustain these exercises long enough to allow stakeholders to fully apply the knowledge bodies and to explore different pathways to the development of sustainable fisheries over the coming decades, such as applying forecasting and back-casting techniques to exploit opportunities and challenges for the next twenty years together. In these workshops, we needed at least three times as much time to establish a transdisciplinary knowledge base for further work on sustainable fisheries. Because of our extensive discussions, which lasted several days instead of the two provisioned for, the first series of workshops ended with the ranking of parameters. Altogether, the transdisciplinary project team would have needed more time and virtual space to continue the process of evaluation and understanding to the point where policy recommendations could have been identified and agreed upon by the relevant stakeholders. The output of this process did not include the activity for participatory scenario development. But our exercises of systems analysis provided an interim base of research findings, which derived from the identifying key parameters and key relationships between them. As we had to adapt the research agenda, the modelling session had been pushed back. So, the team as a whole could not run through the creative process of developing new scenarios and exploring the various pathways they embodied. Reasons for this decision were a) significant restrictions by (non)availability of team members and travel costs, b) the project schedule was very tight and important milestones, such as the delivery of models, were already late. Therefore, the modelling had to be introduced and organized in a one-day workshop and was left to a small team of Austrian team members, which completed the experiment of modelling (see Figure 4).

Challenge of translation and language: In addition to the time factor, a second major challenge was to address the plurality of languages and linguistic resources during scenario development exercises. In terms of languages employed during fieldwork, the team used plurilingual practices, such as translation and interpreting, in order to foster dialogue between researchers, practitioners and the local community on sustainable fisheries policy. As previously shown, using plurilingual practices was very important to allow a dialogue where all participants were on a par with each other. The process of translation was more than the transfer of knowledge from one word to another. Rather it required a critical approach to how we frame and codify knowledge within our disciplines and to learn how others do it. This became evident during the

Figure 4: SUSFISH research results related to food security, sustainable fisheries, water quality boost the potential for development and education in Burkina Faso



whole research process, but explicitly in the interdisciplinary adaptive management workshops.

The involvement of diverse linguistic resources implies a reflection of prejudices, ideologies, and of understanding roles that are associated with different linguistic cultural backgrounds. It also meant to reflect on the exertion of various different symbolic power and inherent power relations the team was not aware of. The predominant use of English as language of scientific communication risked to become a barrier to open discussions at some levels of interaction. The questionnaires, for instance, used scientific and technologically influenced language in the elaboration of key questions and in the applied parameters. In our team, scientists and practitioners adapted quite differently to this kind of knowledge translation applying a terminology with key parameters using numeric values for modelling. The project idea was embedded in the frame of bio-physical research, which provided the leading ideology in defining relevant factors. We added socio-political questions, but these did not constitute the source for developing ways to reflect. For our social scientists it was a learning process to search for the linguistic terms to tell these scientifically framed narratives. It is a question of epistemological positioning; knowledge was much more contextualized in the French, more

hegemonically grounded scientific tradition and therefore in a distinct tradition of narration. Therefore, it was important to develop a sensitive strategy to avoid the temporary exclusion of team members in the transdisciplinary discussions. We experienced for instance that it helped that a small group switched to French or Moore or German to clarify certain points before continuing the discussion in the whole group.

Challenges on an organisational level: As the workshops were highly participatory, this approach needed the commitment and collaboration of every group member. But in practice, it was very difficult to reach this goal in a group of 20 persons, who are partly in key management positions and changing working-conditions. Addressing the challenge of spontaneous changes of availability, the responsible team members tried to focus the joint discussions on issues following the disciplinary divide of bio-physics and socio-political sciences. It became evident that those discussions, which were held as plenary and thus interdisciplinarity, were much richer in terms of comprehensive input and shared learning.

5.1.8. SUSFISH's participatory approach: lessons learned and problems

Overall, the project team achieved important progress in generating knowledge in terms of new concepts, facts and perspectives about aquatic ecology, water quality assessment methods as well as fisheries and water management practices in all 13 regions of Burkina Faso.

The two PhD students from Burkina Faso, who were also partly studying in Austria, and the four Austrian MA students, who studied in Burkina Faso, as well as the 13 Burkinabè MA students in Burkina Faso, formed a group of young scholars who wanted to reflect on different research contexts. They spent many weeks together, discussing, analyzing, and learning. Together they had the opportunity to experience practical constraints and to learn how to integrate this transcultural and interdisciplinary experience into the research process. At the end of SUSFISH, the first generation of publications and theses show an impressive contribution of junior scientists based on the joint and reflexive research process of collecting data during fieldwork. Anyhow, the time when all students from every discipline were together was too short for them to deeply learn and to benefit from other perspectives. Future projects should focus on providing greater opportunities for such interdisciplinary learning.

The 19 students, responsible for data collection and processing, interacted the most with practitioners during their fieldwork. Many of these relationships between students and practitioners were long lasting and included an intensive, highly participative joint research process. Our project design was flexible enough and would have allowed for their participation in the process of systems analysis. We could have incorporated them, when we designed events. But actually, their participation was prevented by several reasons: It was generally hard to assemble the whole team, we would have needed several more meetings just with the students to include the diverse perspectives from such a large group. The flexible design ran into constraints of time and money. Hierarchical aspects of supervisor-student relations did not made room for their active participation. In terms of project design, they were not explicitly integrated on paper. However, we could have insisted on this from the beginning. Their participation in this crucial part of the project would have enriched our discussions and improved the process of systematization of knowledge. Including students and other local actors, such as fishermen or fishmongers, in addition to the scientific and political representatives in the debate, would have been a significant contribution to rigorously identify how to exploit opportunities and circumvent challenges to a successful establishment of fisheries science and management in Burkina Faso over the next 20 years.

The participation of local authorities and practitioners from the fishing communities, in joint research activities was intensive in terms of knowledge elicitation and data collection on a local level, but not in the evaluation of research findings. Had the project lasted longer, a reviewing process of SUSFISH findings with local actors would have been a significant contribution from both groups. One goal of the project was a "communal review" to share outcomes and information with actors on the local and regional levels. For reasons of time constraints and project monitoring we did not succeed in this point. With this communal review, we possibly could have achieved our goal. But it is also a matter of fact that for instance data processing in a scientific environment framed by academic expertise is hardly accessible for local actors. Therefore, alternative ways of interaction are needed. For example, it could be an interactive workshop for evaluation, where local fishermen's expertise can be considered even at this level of research activities. The final symposium in Ouagadougou, which was held as a public event, was a great experience in terms of examination by practitioners. As delegates from 36 associations and organizations at local, regional and national level were present

and participated vividly in the debate, the challenge for us is how to continue such multi-level exchange after the project ends.

The interaction between students and policy makers in the frame of gender methodology workshops contributed significantly to the transdisciplinary approach of SUSFISH in comparison to the workshops, which were held within disciplinary boundaries. These joint meetings were on site and enabled mutual understanding and joint learning, as the gender related activities showed. Furthermore, the reviewing activities (fieldwork tool kits, questionnaires, results and reports) of the gender expert became a source for defining further questions. The research team became aware of this important contribution and implemented these evaluating measures for other project reports. But time was too short to cope with the organization of a joint evaluation workshop at academic level before the project end.

For a synthesis of research findings, scenario development and systems analysis were applied in workshops and modeling sessions in a very short time period during the project's last year. These tools require substantial inputs from the whole project team, because they entail complex processes of reflection and discussion to address interdisciplinary questions. Sustaining such discussions requires full commitment by participants and cannot be managed by a single person. The process of negotiating meaning and mutual understanding in a highly transdisciplinary context was enriching and improved the joint knowledge base, but it was a challenge for all members to link the various components in a very short time period. This reflexive discussion successfully led to the formulation of a strategy discussed in a presentation for ministerial stakeholders and decision makers. However, SUSFISH ended when dialogue with politicians started, a point when the project's collective experience should be applied while data is current and most useful. Future projects should initiate such dialogues in an earlier phase. The final phase should extend them to jointly develop a set of strategies with policy makers and practitioners as part of identifying scenarios to successfully establish sustainable fisheries management.

Overall, the synthesis was an important contribution of the project to initiate this process of learning and understanding. The outcome was two sets of lessons learned and remaining open questions that can help define future research agendas. The process of knowledge transformation and understanding is still ongoing, and was an important part of SUSFISH work. But to all of us, it was an experiment to use tools such as scenario development for it,

and we learned, that these interactions need to be considered appropriately in the research design in terms of expenditure in time and costs.

Participatory research enables continuous learning. We experienced very different modes of learning at those various layers where participatory exchange of knowledge happened in our project. To illustrate how and by whom meaning was co-created and our understanding enhanced, we will refer in the next section to selected moments of our joint process of systematization of knowledge and reviewing our findings. The gender sensitive approach introduced to SUSFISH will serve as example, as it provoked contestation because of inherent power structures and a donor-driven ideology. Questions of language resources are crucial, when it comes to debate and contestation. In SUSFISH we used plurilingual practices, but as it revealed aspects of ideological positioning translation we will also point to translational practices and the role of communicative possibilities in the context of epistemological hegemonies.

5.2. Key moments of participatory research

5.2.1 Scenario development workshops - key to understanding

Predicting and managing a complex and evolving world is difficult. Adaptive management represents experiments in new ways to learn and adapt science, policy and practice even as one manages a socio-ecological system (Sendzimir et al. 2017). The imperative to flexibly manage in adaptive management prioritizes processes that generate learning, meaning, knowledge and experience of ecosystem dynamics (Folke et al. 2005). The SUSFISH project embedded such learning processes in a series of scenario development workshops. In these exercises, team members representing academia and policy co-created knowledge about factors key to alternative scenarios of how fisheries management might be developed in Burkina Faso. Our team objectives in these workshops were to learn-by-doing participatory science to contribute to establish it as another option in the support of policy formulation and application in Burkina Faso. Therefore, the exercises allowed participants to mutually develop skills to analyze and communicate complex ideas and formulate policy as well as to study the factors influencing the dynamics of water and fisheries management in Burkina Faso (Peterson et al. 2003). By and large, the methodology adopted to develop exploratory storylines during the first workshop series

followed a procedure of three stages: a first stage is geared towards identifying of main concerns about future developments; a second stage focuses on the discussion of key uncertainties and driving forces; and a third stage develops the actual scenarios. It is important to mention that this approach of scenario development was introduced for the first time to the majority of team members.

The workshops were initially based on a diversity of approaches to embrace different perspectives in a knowledge co-creation process. Through dialogue and storytelling, we aimed to shape the definition of phenomena and problems related to the future of Burkinabè fisheries. When starting storyline development several steps were taken within SUSFISH to increase the number of iterations, the most important being to start with an existing set of scenarios. This eliminated the most time-consuming step of building storylines from scratch, thereby speeding up the process and increasing the number of iterations of the Story-And-Simulation cycle. To that end, we collected this first set of scenarios with short narrations already prior to the workshop, which could serve us to elicit a set of important issues. With the purpose to elicit standardized narrations and to establish a common language across the project team to facilitate learning, we used a questionnaire, which was sent to all team members.

The questionnaire was designed for eliciting knowledge by focusing attention through a set of questions. It asked for 1) processes or trends influencing fishery sustainability, 2) key words, 3) scenario showing how sustainability is influenced (3 sentences or less), 4) important factors involved in this scenario, 5) relations between factors that influence this scenario (factors involved, how they interact, results) and finally 6) key questions or uncertainties. The questionnaire was sent out via e-mail and team members had about three weeks to fill it and send it back before the workshop. Further information how to use the questionnaire was provided only written.

Except for the students in Austria, not attending the workshop in Burkina Faso, an extra workshop on storytelling and formulating key questions was held in advance. The response to this questionnaire from Burkinabè partners was very low, only a few questionnaires on issues in natural sciences came back, and therefore the elicitation of key parameters was very limited. The reasons why this instrument was not functioning remained unrevealed. However, based on our experience of the effectiveness of face-to-face dialogue we adapted such questionnaires into a structured interview format because the questionnaire was obviously not acknowledged as a tool by the whole team.

Thus, the schedule was slightly changed and narratives were developed dialogically during two consecutive workshops at the beginning of the modelling exercise. We collected interactively short narrations among all participants. Every member was given a large degree of freedom, in terms of how to frame and express with own words and in a familiar language, to develop his or her own scenarios or phenomena. In most cases this led to a set of first storylines, in which the starting points were recognizable. In this first step it became evident, that only by working together to answer the questionnaire could the participants become come comfortable and fully respond to the technical language of systems analysis used to frame the questions. It was familiar to the participants, but in different shapes. For instance, the notion of a *scenario* was very abstract in the beginning, it was used as a quite technical term. Therefore, we needed to establish a common ground of understanding how to use this terminology and logic as a tool for our participatory approach. As we were not fully aware of this lacking common understanding, the two workshops were divided in a session focusing on biophysical issues and another for the socio-political questions. It was an important learning effect to the whole group, that it seemed to be more familiar to the experts from natural sciences to formulate key arguments, develop scenarios in three sentences as well as to trigger events. As a consequence, we encouraged all team members to participate in both workshops actively regardless of disciplines and professional expertise. The joint work in crossing disciplinary boundaries helped to identify key factors by breaking out of a technical aid speak and to integrate our different ways of knowing.

During the workshops, collaboration improved as we acknowledged and renegotiated the workshops' purposes, explaining in the process the methodological approach of scenario development and its importance to our findings. This effort was done in several days when we followed consequently the stories brought up in the workshops. In order to tackle complexity of problems we assessed together two types of knowledge: Knowledge academically collected and evaluated and on the other hand co-created knowledge between the involved researchers and practitioners, that is contextualized in social interactions and local systems. This process was quite intensive, enriching but also exhausting sometimes. As previously mentioned, it was necessary to pursue the lively debate in several languages. In some cases, it was necessary to evoke them in languages such as Jula or Moore. And because of plurilingual communication situations it was not evident that all the information and knowledge could be grasped by interpreting after the sometimes, long-lasting

discussions to integrate them in the scenario development in scientific English. Translation became key to understanding and making meaning in this context.

5.2.2. The debate is open: translational practices to negotiate meaning

During the workshops, we experienced translation practices as a valuable instrument to negotiate meaning in order to experiment with new forms of thought and action - socially creative strategies - in order to understand problems and complexity not only through responsibilities, competences, and disciplines. We used them as a tool for the experiment of translating diverse theoretical concepts into the specific research contexts of fisheries and water management in our research areas. To a certain extent, translating showed us how theoretical concepts were constructed. It helped us to explore ways on how to adopt theory to practice.

But before it is important to elaborate on the notion of translation we use in this context. Translational practices do not apply simple linguistic relations, but go beyond equivalence and a copying of the original. We understand them as a continuous process of transformation (Bachmann-Medick 2009). Translation is the work of social worlds and not individuals (Gal 2015) and does not establish equivalence (Sakai 2006). It also involves appropriation and representation. The realm of translating language and text thus opens up to include a wider horizon of cultural translation practices (Bachmann-Medick 2006). It became a fundamental category of analysis in order to meet the transcultural challenges of our research practice and the contentious field of transcultural and transdisciplinary encounters. It is not the textual notion of translation into simplistic metaphors of transmission. An additional, decisive quality of this concept of translation is that it is tied to everyday life and agency and not to a few persons with cultural expertise. In our scenario development sessions, which were linguistically and theoretically very complex, we used this technique for dealing with multi-layered differences and disjunctions in knowledge, perceptions as well as in discourses not only bound to diverse languages, but also to different learning traditions.

Furthermore, interpreting practices among the participants were necessary in these sessions as French, English, Moore and Jula were very important means of communication amongst the participants, but not mutually understood by everybody. We experienced this necessity of inter-

pretation during the discussions on the concept of *subsistence*. The term came up in the elaboration of key parameters for the commodification of fish. During this process, we identified subsistence fishing as a key parameter for questions of how to manage fisheries sustainably in Burkina Faso especially with regard to water health, sustainable water use around the reservoir and issues of environmental pollution. Farmers, who fish during the dry season, act individually, and are not organized within an association or governmental management authority. They use the resource of water for irrigation and for fishing adjusted for their personal needs, and this practice is governed by a traditional management system of natural resources. Introducing commercial fishing to this system exposes a gap in management. In order to integrate this aspect in our scenarios, first of all it was necessary to define subsistence fishing as a measurable category in contrast to commercial fishing. Politicians introduced it to our discussion as a very technical concept, clear-cut and static. It was framed in the development paradigm as *to meet the basic needs of food security*. But the method of systems analysis required us to define relationships to other parameters and along disciplines and revealed the need to better understand different interpretations of subsistence. For instance, in natural sciences it was necessary to clarify if subsistence is measurable by an average earning per fishermen.

Later, the question of surplus came up: is it still considered as subsistence activity with purchases in the market? Social sciences assumed that the short-term planning for livelihood might be a significant characteristic of subsistence, too. In ecology, the concept includes a dimension of sustainable social practice as it can be seen to contrast with larger-scale, more intensive commercial practices. The conflicting overlaps between interpretations seemed first to block attempts to agree on a clear-cut definition as our debate widened to a new dimension of complexity, instead of narrowing down to measurability. But by re-inventing the phenomenon *subsistence* through translational mediation we gained more understanding and became aware of misunderstandings. In this case, the term served as an interaction point of reference. Contradictions and misunderstandings indicated where we should critically reflect assumptions and prejudices. Indeed, the mode of thinking itself also benefits from translational qualities, and limitation of thoughts becomes obvious while reflecting on processes of mediation. As translation is not a unilateral one-way activity, we started with mediation activities. We used several languages for this debate, although some parts of the conversation were not accessible for everybody present in the workshop. The shift to

French and Moore was important, because then the meaning and perception were shifted, and, most importantly, mutually transformed. For instance, we gained insight regarding the hegemonial aspects inherent to this concept, such as the implicit connotation with poverty, primitive societies and backwardness framed by *tradition*. We assume that theoretical terminology is not simply a given static entity, but is created in a continuous process through translation in the first place. It also questions notions of origin as well as concepts of authenticity: in our case the distant habitus of policy-making institutions became evident, who fail to take into account dimensions such as special skills and knowledge of local resource users.

While we did not end up the discussion with a new clear-cut definition, translational processes allowed us to grasp in much more differentiated ways the term subsistence as it is widely used, but the process of learning how to understand better was very rich. In this regard we experienced traditional fishing practices as un-stable categories, and as a place of active transition and of cultural production of *creolization* - such as the translational adaptation of elements of French (neo)colonial dominant rhetoric, or its assimilations.

For us it was an important process to break up clustered, blanket conceptions of "intercultural" difference into singular steps of translation through which acts of understanding, mediation can be revealed, and misunderstandings and communication blockages become acknowledged rather than obscured. It induced us to reflect on how our own culturally specific positions - although seeming very objective, are loaded with ideologies on marginalization and disadvantage.

These activities are not necessarily always smooth or successful or capable of "bridging gaps", but differentiation enriches analysis. Furthermore, it embodies the basic elements for a self-reflection of transdisciplinarity. Only by exceeding the current limits of explorations at the borders of the disciplines it was possible to better understand the zones of overlap between different disciplines as perhaps conflictual yet productive and readily negotiable zones of translation. But it is vital to this approach of mediation processes to be sensitive to translational qualities, which allow differentiation and which enrich rather than simplify meaning. It is indispensably indirect, mediated by a third party and should include the acknowledgement of disruptions, rejections, misunderstandings and conflicts that can occur in our research processes. Most importantly this is tied to the ideological and perilous role of the translator him/herself as a cultural and language broker (Jacquemet 2005), which has to be reflected in every transdisciplinary research process. Trans-

lators constitute knowledge and speech style and precisely such qualities of inconsistencies, obstacles and resistance are predominantly obscured from view in participatory approaches (Gal 2015). Understanding is a fundamental aspect of knowledge production processes, these become more complex when multilingual practices and translocal contextualization, reconceptualization and the translation of knowledge are involved (Langthaler et al. 2012). In our interactions we had to deal with internationally established knowledge in English scientific and often political registers, by translating them on our own we started to reflect our own positions and to revise our professional rationality. But as Gal (2015: 233) argues, a semiotic analysis of these components of (Latourian) translation would clarify the parallel ongoing processes of transformation and recreation.

Much knowledge was produced and also gained by means of translation and by questioning our own culturally specific positions, analytical concepts, and theoretical assumptions. The understanding of local concepts is therefore the result of an ongoing process whose point of reference is situated within the complex field of conflicts defined as socio-cultural peculiarities. Here it was very important to no longer see cultures as holistic and self-contained phenomena, with a common ground for their contexts of meaning. Discussions of cultural features exhibited the interwoven discourses of colonial and postcolonial thoughts. Translation is not conceived of as a strategy of simplification and of diminishing the issue's complexity, i.e. it is not a dichotomist way of handling cultural differences. We had to deal with the complexity of differences - and we did not only establish differences, but also considered their scope of negotiation by applying a strategy of interpretation and mediation.

Part of such a task of translation required the consideration of power hierarchies and asymmetries that were also evident in knowledge traditions. To us it was important to become aware of the highly diverse set of hierarchical systems we were involved in. For the SUSFISH team the concept of gender balance within our research agenda provided an insight to this multi-layered, interferential system of concepts and ideologies.

5.2.3. The debate on gender

We made significant progress in examining aggregate patterns of social interaction and their influence on natural resource management. By discussing our different, sometimes diverging perceptions and also by interpreting cer-

tain issues, we could even deepen our understanding of other perspectives on gender topics. But in the beginning, it was a real challenge for the group to accept a gender sensitive approach applied across all disciplines. As a condition for funding, it was introduced as a hegemonic concept into the SUSFISH research agenda. The team coped with this challenge by engaging a gender expert. And because of her expertise and experience, she started to involve the team members, despite their opposition, in gender workshops and trainings in order to introduce gender-sensitive indicators and tools for data collection, as already outlined in the previous section. But the majority of in-country project partners continued to be irritated, questioning the meaningfulness of such trainings for biophysical scientists. During the scenario development workshops the debate on gender issues became quite imbalanced, reinforcing obscure assumptions on both sides.

In one of the first workshops, held after two years of cooperation, very controversial positions ensued on the usefulness of a general application of this concept on our project. The debate revealed the very abstract nature of this concept, which policy makers had introduced in a very technical manner and prioritized by making its study contingent on funding. It was framed in clear-cut definitions of expert's register that subsumes basic rights in a citational practice (see Gal 2015). Therefore, in the beginning of our discussions, it was a highly contested issue because the whole gender approach was reduced to the numeric equivalence between men and women and the conflict revolved around feelings of injustice. It was not acceptable for everybody that, for instance, male students applying for grants within the project should be disadvantaged because of the low rate of female researchers in our team. Some experiences of involving female students in fieldwork activities were negative, because of their low engagement and a very modest interest for bio-physics in general. Questions of structural discrimination or social exclusion of female students in the context of education and academic career development were not raised until the discussion turned on the family situation of a female researcher of the team. Now the gender expert started renegotiating the concept and could explain to her colleagues why a gender strategy in the fisheries sector also needs to integrate female perspectives. She started to translate this very theoretical concept by re-contextualizing it to the female researchers' perspective. At the same time, the gender expert's role completely changed within the team. She had followed the discussion for a long time without any substantial objection to the debate dominated by her male colleagues. But

on the dispute about equal access for female students to natural sciences she started to provoke contradiction in order to elicit hidden assumptions.

At the beginning, in our questionnaires and hierarchization exercises, categories such as *marginalized people*, *equitable development* and *participation* were used like exclusive items, serving an expert jargon within the hegemonic paradigm of development. For the process of renegotiating meaning, it was very important to have an interaction on this in the team. Together we started to examine categories and analytical concepts in terms of their translatability in the realm of gender issues, to open them up and create a transgressive common understanding for our research agenda in several languages. And again, the concept of language we use is not a concept of bounded entities clearly separable by names and categories, such as Moore, French or English, but a space to learn about meaning in between varieties, linguistic features and jargons (Makoni et al. 2007). Terms such as marginalization were discussed among the Moore-speaking group in order to explore matters of oppression and discrimination of women in rural areas. It helped to realize that our perceptions of rural work and household organisation are quite distant to the life world of fishing communities. As a consequence, research data and preliminary results were shared, discussed and evaluated in workshops with women associations. The debate on gender issues in bio-physics remained controversial, especially about correlations of processing fish practices and the diversity of fish species. We could not agree about the integration of gender-related categories in our interpretation of data on biodiversity and water health, but it was important that we confronted contradictions. Misunderstandings changed in terms of exceeding the current limits of explorations at the borders of the disciplines. It clearly helped us to explore new, more appropriate definitions, which were developed on a common ground of understanding. We shared a broader "cross-categorical translation" as a way of opening up this mechanism in a critical manner (Chakrabarty 2000). It was possible to better understand the zones of overlap between different disciplines as perhaps conflictual yet productive and readily negotiable zones of translation. As participants in transdisciplinary dialogues, we were designated to discover new interconnections between allegedly different dimensions of social exclusion. It helped us to understand better that it is crucial to transdisciplinary research to have a team of women and men, regardless of the disciplines and research areas.

5.3. Conclusion and main learnings

This project illustrates how a transdisciplinary research approach can reveal important cross-sectoral phenomena in sustainable fisheries in Burkina Faso. SUSFISH was founded by natural scientists and is based mainly on biophysical science. It explores the possibilities in analyzing fisheries in order to manage them sustainably. Therefore, the conceptualization integrated knowledge from social sciences, but in a very technical manner and only in the final phase of the project. A few workshops on modelling and synthesis exercises among scientists and policy makers provided room for discussion across disciplinary boundaries. More than 100 scientists, students, experts, fishermen, and others were directly involved in SUSFISH for a four-year period of cooperation. Their participation on a platform to bring their knowledge together happened only at the end of the project, organized as a final conference meeting. Due to very limited financial resources, the synthesis process to establish a joint foundation of knowledge could not include them all. The project would have benefitted had the local experts on all levels been more involved.

There were moments of applied participatory research as described by Haller et al. (2016), but participatory research was not conceptualized as a comprehensive approach. Moreover, participatory research moments were restricted to the following three levels: field research, training for local groups, and scenario development. It is important to note that the first two moments, data collection in the field and training of local groups, were not considered to be important interdisciplinary learning contexts. Hence, they were organized along criteria of group membership, time, and place - and strictly within disciplinary boundaries. It was assumed that the third step, the synthesis process, would provide local experts' knowledge to the joint exercises among the core team - transmitted by the responsible scientists - in order to develop scenarios together. We realized that this strategy to integrate knowledge step by step from a local to a more general view was theoretically sound, but only partly successful in research practice. Had there been an ethnographic approach, such as participant observation and qualitative interviewing as back-up to accompany the activities with local practitioners, important insights would have been taken more into consideration by the scientific experts. This would have had practical implications for every step taken regarding the design and application of questionnaires, policies, scientific knowledge and would have made the integration of local ecological knowledge possible.

Ideological assumptions on local knowledge and the role of experts hindered a broader recognition of local expertise as data. This should be thoroughly analyzed, not only presented as experience gained or as individual stories.

In our reflections regarding the process of synthesis happening at the third level of participatory research moments, we concluded that the effort to look thoroughly across disciplines can never be comprehensive in such a short time and with only a few meetings involving all experts. SUSFISH can thus be regarded as an exercise allowing for joint learning processes, which, in turn, can help extract the most important factors shaping ongoing questions for future shared research.

But beyond that we also experienced participatory research as taking place largely in controversial debates, full of inconsistencies, obstacles, and resistance. The participants' mutual work of collecting, analyzing and negotiating the meaning of information involved acknowledging these disruptions, rejections, misunderstandings, and conflicts. We used these meetings in a similar way as described for the constitutionality process (Haller and Merten 2018) and experienced them as a strategy for politicians and scientists to examine the dynamic implications of the facts and questions generated by the project. Very important was the process in terms of negotiating meaning and finding a compromise.

In retrospect, basic obstacles were the following:

- A short time frame: The transdisciplinary learning process was considerably more intensive as anticipated and would thus have needed much more time for discussion, as it took place largely through controversial debates. Therefore, transdisciplinary research activities are one of the most important contact zones, which should be planned rigorously from the beginning. An important lesson learned is to organize research activities along a continuous sequence of dialogic transdisciplinary activities for the whole duration of the project.
- One core element of our SUSFISH research was to establish and intensify cooperation among the many partners (nationally in Burkina Faso and in Austria as well as internationally between institutions of both countries involved) and was obviously too ambitious. The organization of a set of cooperation-promoting activities, such as joint interdisciplinary field trips, transdisciplinary workshops, joint lectures, shared supervising models for students (cross institutionally), system analysis, and concept modelling, was thus a challenge as well.

- Power asymmetries regarding class and gender: We realized too late that integrating students and important stakeholders in these learning and evaluation processes would have been very important. But a key question is how to organize such a space for debate in terms of time, languages, and power hierarchies. Another challenge was how to provide platforms to engage different stakeholders involved in the fisheries management at all levels and in group compositions, thus allowing them to interact.
- Power asymmetries are interwoven with language issues as well. An additional challenge is the issue of access in terms of language, education, and knowledge in such participatory debates. The involvement of diverse linguistic resources implies a reflection on prejudices, ideologies, and an understanding of roles. It also requires methods of linguistic anthropology to reflect on the exertion of symbolic power and inherent power relations the team was not aware of.
- Much knowledge was produced and also gained by means of translation and by questioning our own culturally specific positions, analytical concepts, and theoretical assumptions. The process of translation was more than the transfer of knowledge from one word to another. But we did not assess these communicative practices qualitatively. Later on, it was not possible anymore to analyze our social interaction in detail. The approach definitely requires ethnographic tools in order to grasp the process of knowledge framing and codifying, the translational practices within our disciplines, and to learn how others do it.
- Another obstacle to overcoming scientifically-based language we experienced in the SUSFISH project is written into the paradigm of development cooperation. This approach by its very nature implies inherent power asymmetries and imbalanced relationships due to obscure assumptions and expectations. These were implicit and therefore remained uncontested for a long time. But the conceptual space of modelling workshops obliged us to formulate some of our concerns and ideologically loaded assumptions. In addition, our discussions revealed that language and terminology play a crucial role in reconfirming development-driven concepts as well. Scientifically codified language was removed step-by-step for systems analysis reasons in order to open up a discussion about prejudices, ideologies, and an understanding of roles. We experienced plurilingual practices as a very important tool to allow for a dialogue on a par with each other.

Studying fisheries with natural science techniques based primarily on biophysical research does, in itself, not produce the requested solutions for sustainable management as our findings in social, economic, and political sciences showed. The exercises in systems analysis revealed a lack of insight regarding the patterns of social systems (blind spots), which are very much related to the ecological systems. The results of case studies in various sites clearly showed the need to understand local economies, political structures, and plurilingual practices as well as local knowledge. Yet even more prominent was the need to understand existing, often inherent power relations among local groups as well as among international experts. This experience includes a deeper understanding and learning in a transdisciplinary process in all research activities. A recurrent challenge to this method was the planning and working in a broad heterogeneous team.

5.4. References

Bachmann-Medick, D. (2006). Cultural Turns. Neuorientierungen in den Kulturwissenschaften. Reinbek bei Hamburg: Rowohlt.

Bachmann-Medick, D. (2009). Introduction: The translational turn. Translation Studies, 2(1), 2–16.

Berkes, F. (1999). Sacred ecology. Traditional ecological knowledge and resource management. Philadelphia: Taylor and Francis.

Bhabha, H. (2000). Die Verortung der Kultur. Tübingen: Stauffenburg.

Bourdieu, P. (1996). Understanding. Theory, Culture and Society: Explorations in Critical Social Science, 13(2), 17–37.

Chabwela, H.N. and Haller, T. (2010). Governance issues, potentials and failures of participative collective action in the Kafue Flats, Zambia. International Journal of the Commons, 4(2), 621–642.

Chakrabarty, Dipesh. (2000). Provincializing Europe. Postcolonial thought and historical difference. Princeton: Princeton University Press.

CNID-B. (Comité National d'Irrigation et de Drainage du Burkina Faso). (2010a). Diagnostic participatif du périmètre irrigué de Karfiguéla. Internal report. Ouagadougou, Burkina Faso: IWMI.

CNID-B. (Comité National d'Irrigation et de Drainage du Burkina Faso). (2010b). Diagnostic participatif du périmètre de Talembika. Internal report. Ouagadougou, Burkina Faso: IWMI.

Foucault, M. (1981). The order of discourse. In: Young, R. (ed.). Untying the text. A post-structuralist reader (pp. 48–78). New York: Routledge and Kegan Paul.

Folke, C., Hahn, T., Olsson, P. and Norberg, J. (2005). Adaptive governance of social-ecological systems. Annual Review of Environment and Resources, 30, 441–473.

Gal, S. (2015). Politics of translation. Annual Review of Anthropology, 44, 225–240.

Haller, T., Acciaioli, G. and S. Rist. (2016). Constitutionality: Conditions for crafting local ownership of institution-building processes. Society and Natural Resources, 29(1), 68–87.

Haller, T. and Merten, S. (2008). "We are Zambians—Don't tell us how to fish!" Institutional change, power relations and conflicts in the Kafue Flats fisheries in Zambia. Human Ecology, 36(5), 699–715.

Haller, T. and Merten S. (2010). "We had cattle and did not fish and hunt anyhow!" Institutional change and contested commons in the Kafue Flats floodplain (Zambia). In: Haller, T. (ed.). Disputing the floodplains (pp 301–360). African Social Studies Series 22. Leiden: Brill.

Haller, T. and Merten, S. (2018). Crafting our own rules: Constitutionality as a bottom-up approach for the development of by-laws in Zambia. Human Ecology, 46(1), 3–13.

Jacquemet, M. (2005). Transidiomatic practices: Language and power in the age of globalization. Language and Communication, 25, 257–277.

Kaboré, I., Moog, O., Alp, M., Guenda, W., Koblinger, T., Mano, K., Ouéda, A., Ouedraogo, R., Trauner, D. and Melcher, A. (2016a). Using macro-invertebrates for ecosystem health assessment in semi-arid streams of Burkina Faso. Hydrobiologia, 766(1), 57–74.

Kaboré, I., Jäch, M.A., Ouéda, A., Moog, O., Guenda, W. and Melcher, A. (2016b). Dytiscidae, Noteridae and Hydrophilidae of semi-arid waterbodies in Burkina Faso: species inventory, diversity and ecological notes. Journal of Biodiversity and Environmental Science, 8(4), 1–14.

Kok, K., Van Vliet, M., Dubel, A., Sendzimir, J. and Bärlund, I. (2011). Combining participative backcasting and explorative scenario development: Experiences from the SCENES project. Technological Forecasting and Social Change, 78, 835–851.

Langthaler, M., Witjes, N. and Slezak G. (2012). A critical reflection on knowledge hierarchies, language and development. Multicultural Education and Technology Journal, 6(4), 235–247.

Mano, K. (2016). Fish assemblages and fish-based assessment of the ecological integrity of river networks in Burkina Faso. Unpublished PhD dissertation. BOKU, University of Natural Resources and Life Sciences, Vienna.

Mahé, G., Paturel, J.E., Servat, E., Conway, D. and Dezetter, A. (2005). Impact of land use change on soil water holding capacity and river modelling of the Nakambé river in Burkina-Faso. Journal of Hydrology, 300, 33–43.

MAHRH (Ministère de l'Agriculture, de l'Hydraulique et des Ressources Halieutiques). (2003). Action Plan for Water Resources Integrated Management (PAGIRE). Ouagadougou. Burkina Faso: MAHRH.

MAHRH. (2006). Politique nationale de développement durable de l'agriculture irriguée. Stratégie, plan d'action, plan d'investissement à l'horizon 2015 – Rapport principal, MAHRH, Ouagadougou, Burkina Faso: MAHRH.

Makoni, S. and Pennycook, A. (eds.). (2007). Disinventing and reconstituting languages. Clevedon: Multilingual Matters.

Melcher A., Ouedraogo, R. and Schmutz, S. (2012). Spatial and seasonal fish community patterns in impacted and protected semi-arid rivers of Burkina Faso. Ecological Engineering, 48, 117–129.

Melcher A., Ouedraogo, R., Moog, O., Slezak, G., Savadogo, M. and Sendzimir, J. (2018). Healthy fisheries sustain society and ecology in Burkina Faso. In: Schmutz, S. (ed.). (2018). Riverine ecosystems management. Science for governing towards a sustainable future (pp. 519–540). Aquatic Ecology Series 8. Cham: Springer.

Ouédraogo, R. (2010). Fish and fisheries prospective in arid inland waters of Burkina Faso, West Africa. Unpublished PhD dissertation. BOKU, University of Natural Resources and Life Sciences, Vienna.

Peterson, G.D., Cumming, G.S. and Carpenter, S.R. (2003). Scenario planning: a tool for conservation in an uncertain world. Conservation Biology, 17, 358–366.

Petit, O. and Baron, C. (2009). Integrated Water Resources Management: From general principles to its implementation by the state. The case of Burkina Faso. Natural Resources Forum, 33, 49–59.

Sally, H., Lévite, H. and Cour, J. (2011). Local water management of small reservoirs: Lessons from two case studies in Burkina Faso. Water Alternatives, 4(3), 365–382.

Sakai, N. (2006). Translation. Theory Culture Society, 23(2–3), 71–86.

Sanon, V.-P. and Toe, P. (2015). Gouvernance et institutions traditionnelles dans les pêcheries de l'ouest du Burkina Faso. Etudes africaines. Paris: L'Harmattan.

Sendzimir, J., Reij, C.P. and Magnuszewski, P. (2011). Rebuilding resilience in the Sahel: regreening in the Maradi and Zinder regions of Niger. Ecology and Society, 16(3), 1.

Sendzimir, J., Magnuszewski, P. and Gunderson, L. (2017). Adaptive management of riverine socio-ecological systems. In: Schmutz, S. and Sendzimir, J. (eds.). Riverine Ecosystem Management - Science for governing towards a sustainable future (pp. 301–324). Aquatic Ecology Series 8. Cham: Springer.

Stranzl, S. (2014). Quantification of human impacts on fish assemblages in the Upper Volta catchment, Burkina Faso. Unpublished Master thesis. BOKU, University of Natural Resources and Life Sciences, Vienna.

Thompson Klein, J. (2004). Prospects for transdisciplinarity. Futures, 36(4), 515–526.

Venot, J.P. and Cecchi, P. (2011). Valeurs d'usage ou performances techniques: Comment apprécier le rôle des petits barrages en Afrique subsaharienne? Cahiers Agricultures, 20(1-2), 112–117.