Chapter 2
Methods and sources

In order to explore the diverse experience of AWIs, the GAWI partnership decided to search for cases of such interactions across the world and to apply a standard analytical tool to them. In order to obtain cases, all GAWI partners volunteered to submit studies, drawing from their own experience or from materials obtained through partner organizations. In terms of the standardized analysis, it was recognized that cause–effect chains were common in the AWI experience but that this was a rather simplified conceptualization of the situation. Consequently, the DPSIR model was chosen for use in analysing these cases (below) as it was felt to be more comprehensive than the cause–effect model. It was also felt that the DPSIR model would provide a framework with comparability with the work of the MA, which had used the DPSIR concepts but in a slightly different form.

ACQUIRING THE CASE STUDIES

Sources

The GAWI partners provided about one-third of the cases that were obtained for analysis, the majority of these coming from WA (with an African focus), Wageningen University (with a European and Neotropics focus), WI and FAO (with an Asian focus), and IWMI (with an Asian and Oceania focus). In addition, a request for case studies was posted on the Ramsar listserve, and a small number of responses were obtained from this.

In order to try to ensure more comprehensive coverage, an extensive search of academic literature was undertaken using the on-line Scopus journal database (Scopus is the largest available abstract and citation database of peer-reviewed literature). Initially, a search of the terms "wetlands" together with "agriculture" in the title, abstract and keywords of the online content was undertaken, and this yielded 1 093 references between 1985 and 2007. Subsequently, the search was widened to include other keywords, such as marsh, swamp, irrigation and drainage (Table 4).

Given the large number of articles identified, a key challenge was to identify those most suitable for use in the identification of GAWI case studies. Suitability was determined on the basis of the following process:

- A quick examination of the title of each article ascertained whether it reflected AWIs, and whether the text was likely to contain information relevant to the DPSIR framework. (It was noted that the vast majority of

TABLE 4
Search terms and results of academic database interrogation

Search terms	Number of articles listed
Wetland + agriculture	1 093
Wetland + drainage	1 545
Swamp + agriculture	150
Marsh + agriculture	259
Wetland + irrigation	554
No. articles downloaded for preliminary analysis	85
No. used in GAWI case studies	43

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articles were not particularly useful as they focused in great depth on only one or two particular elements of AWIs, e.g. plant performance in constructed wetlands, or chemical properties of agricultural runoff. These were considered unlikely to yield information relating to the full range of elements in the DPSIR framework, resulting in incomplete case studies. Hence, they were discarded.)

- For articles with titles that appeared suitable, an initial reading of the abstract was undertaken to ascertain whether the article was likely to yield sufficient relevant information suitable for inclusion in the DPSIR framework.
- Where the above two criteria were met, the article was downloaded, analysed, and a DPSIR checklist compiled simultaneously (below and Annex 2). Where, after analysis of an article, there was found to be insufficient or irrelevant material to include as a GAWI case study, a general Web search was undertaken to identify any additional information. In many cases, this approach did not yield further information and, hence, the article was discarded.
- In those articles considered suitable, the reference list was checked for additional relevant information, and, in many instances, these additional articles were downloaded, analysed, and the data added to the DPSIR case study checklist (below). General Web searches were also undertaken to triangulate information and consolidate the case studies. This often involved the identification of relevant grey literature contained on government Web sites or those of non-governmental organizations (NGOs).

Additional cases were obtained from participants at the expert meeting held in Wageningen in October 2007 to review a draft of the framework document and a series of issue papers relating to how to take the GAWI work forward. These cases were usually followed up through Web sites and e-mails with contact persons.

Despite the problems in identifying cases and obtaining literature on them, after a considerable period of work, more than 100 cases were identified from the various sources. Of these, 90 were processed using the DPSIR model (Annex 3).

Methodological limitations

The coverage of AWIs obtained in this way was far from complete or unbiased. In the first instance, the GAWI partners provided material from their areas of expertise, which reflected both the locations of their work and also their particular professional skills. This aspect of professional influence was also seen in the literature search. It was clear that certain types of AWIs (water quality being a particular example) attracted funding for studies and so were reported in the literature more than others. Moreover, within the cases used, there was incomplete coverage of the AWI elements. In one case, soil characteristics were studied, while this was not done in another case. In several cases, socio-economic differentiation was given limited attention compared with water tables and flooding regimes. As a result, care should be taken when comparing the cases as the absence of information on one aspect of AWI may be more a result of the professional skills and interests of the author rather than the actual situation. The use of the online search method may have also led to an emphasis on direct *in situ* AWI cases, and to the neglect of indirect basin-level cases.

In addition, the use of the DPSIR model (below) also affected the selection of case studies. For example, more general articles describing sustainable or traditional AWIs were not covered well by the model because pressures, impacts and state changes were not elaborated upon in the material. Hence, rather than presenting a case study that lacked information on many components of the model, such cases were usually discarded, even though in reality there may have been important findings for sustainable AWIs. Some of these cases did remain where there was reasonably full information, and these are discussed in Chapter 9.

In a small number of cases, some potentially relevant articles considered were not available to download (these being published prior to the mid-1990s). However, it should be stressed that the bulk of the database search covered the period from 1985 to 2007.

Reflecting on the cases obtained, it is relevant to note how little "joined-up" work on AWIs in particular locations, or sites, was found in the cases studied. For example, many articles discussed wetland management in depth without addressing the drivers and pressures that are fuelling emerging issues. Others papers focused entirely on biophysical state changes without any appreciation of the wider socio-economic context. This is a key area for future research and one that the GAWI initiative should address.

ANALYSING AGRICULTURE–WETLAND INTERACTIONS

The DPSIR framework

The DPSIR framework has been used by a range of agencies for the analysis of different situations. It builds on input–output models developed by economists in the Organisation for Economic Co-operation and Development (OECD) and Eurostat, and has been used by environmental economists, not so much as an analytical tool, but more as an auditing framework, e.g. by Turner *et al*. (2000). Their use of the model was specifically with reference to the Fen wetlands in the United Kingdom, while their particular focus on auditing meant that the definitions of the elements in the model were rather specific.

Operationalizing some elements of the model, especially with respect to pressures and state changes, proved challenging at times. However, an agreed terminology was achieved, similar to that in the paper by Turner *et al*. The definitions of the elements in the model are outlined below.

Elements of the DPSIR framework

For the purpose of the GAWI work, the following definitions were used. Specific examples are provided here for clarity. In all cases, these are specifically focused on AWIs. The MA equivalents are given in parentheses after the title for each category.

Drivers (indirect drivers)

These are any natural (biophysical) or human-induced (socio-economic) factors that lead directly or indirectly to a change in the wetland ecosystem, or in socio-economic processes that influence wetlands and AWIs. Simply put, drivers are the underlying causes that lead to pressures on wetlands or agriculture–wetland-related processes.

Examples are: population dynamics, market development, natural environmental processes, government policies, and community behaviour.

Some drivers operate by influencing ecosystem processes. For example, market opportunities may lead to the establishing of a sugar-cane estate and so changing land use in a wetland, while population growth may cause agricultural expansion into a wetland. Some drivers operate more diffusely, by altering other drivers. They may be seen as "deeper causes", such as broad policies or their failings, international economic circumstances, and the cultural value systems in a society, which create other specific influences on people's behaviour and situations.

Pressures (direct drivers)

Pressures are the consequent results of the drivers on the wetland environment or wetland-related agriculture and any associated socio-economic developments. Pressures are how the drivers manifest themselves on the wetlands and wetland-related societies/activities through processes related to the transformation of wetlands

or the disturbances of their ecological state. In other words, they represent strategies to satisfy the drivers. They are seen here as processes, or activities, that are operating on a generalized scale.

Examples are: agricultural colonization in wetlands, vegetation clearance, agricultural intensification, nature conservation, and water resources management and use.

State changes (changes in ecosystem services)

State changes in the (wetland) ecosystem can be described in terms of biophysical processes that determine the ecological character of the ecosystem and/or the natural resources base. They include changes in the quantity and quality of the various environment elements in the wetland (soil, water, plants, animals, etc.) and their consequent ability to support the demands placed on them (for example, biodiversity, environmental functioning and their ability to support human and non-human life, and supply resources) – in other words, the state of the ecosystem and especially its regulating and support services.

Examples are: water resources, water quality and pollution, soil characteristics (chemical and biological), and biodiversity.

Impacts (human well-being and poverty reduction)

These are the socio-economic results that come from changes in the state of the wetland environment. In other words, they are the way in which the socio-economic characteristics and condition of a wetland society are affected, especially the provisioning services.

Examples are: livelihood gains from market-oriented production, food and nutritional changes in subsistence situations, socio-economic differentiation and conflicts, and recreational development.

Responses (strategies and interventions)

These are actions in response to drivers, pressures, state changes and impacts. These may be technical and institutional or involve policies and planning. They can be implemented by a range of actors.

Some examples of responses are:

- technical or socio-economic actions that try to address specific impacts;
- institutional development by communities that respond to state changes by improving wetland site management coordination;
- planning by basin-level organizations that respond to pressures within a river basin with initiatives for water and land-use management;
- national-level policies and economic development measures that try to address the needs in the society and especially achieve sustainable and ecologically sound economic development;
- international-level responses, including government-to-government types of cooperation, actions of international NGOs (INGOs), and international agreements to which national governments adhere.

Exploration of responses has been limited in most uses of the DPSIR model to date. As a result, considerable attention was given to the question of how best to analyse this material. This led to three characteristics of the responses being seen as important:

- actor,
- measure,
- drivers addressed.

Actor focus

Responses can be found at different levels:

- household – usually concerning day-to-day management;

- community – typically involving local institutions and local policy, as well as coordinated action at a wetland site and maybe the catchment;
- NGOs – often linked to community initiatives, but also including wider perspectives;
- state – involving policies, policy implementation and legislation, major engineering measures and formal research.

Type of response/measure
A second dimension of the responses can explore their nature:

- technical – in terms of specific management practices being addressed, whether these relate to water, crops, natural vegetation, soil or land;
- institutional – in terms of the development of capacity at the community to state level or arrangements for undertaking wetland and catchment management;
- policies from community-level by-laws up to national-level policies;
- planning interventions by the community or the state.

DPSIR focus
A third dimension for thinking about responses is to explore how they address different elements of the DPSIR model and what measures or actions are relevant for these different elements. For example, it is possible to see responses that try to address drivers as needing to have a much wider remit (policy responses perhaps) compared with ones that address state changes that may be specific technical measures.

Applying the DPSIR framework to case studies

An example is developed in Box 1 in summarized form in order to clarify the interpretation of the elements in the framework outlined above. It is elaborated in Chapter 4, where the value of the DPSIR analysis is explored in detail.

ANALYSING THE CASES

Checklists

The understanding of the DPSIR model outlined above was turned into a checklist format (Annex 2) in order to provide a way of summarizing the case studies obtained. While the checklist was primarily a means of identifying the various DPSIR elements in each AWI, it was also a means for identifying areas of common experience between cases, which may inform guidance.

In addition to the DPSIR information recorded for each site on the checklist, six pieces of additional information were recorded to help characterize the situation being studied. These were:

- type of wetland (using all 42 Ramsar categories as in Table 1);
- economic development status of the country (using World Bank data);
- degree of subsistence / market orientation of the agriculture;
- degree of water control – full, partial or none;
- Ramsar region;
- type of AWIs (as in Figure 3).

The construction of the checklists from the diverse case material was undertaken by ten people, although the vast majority were compiled by a three-person team. This compiling of the checklists from literature and other sources involved a filtering-out of information and, hence, the compilers could "stamp their mark" on the work at this stage, or influence the information selected for the next stage in the work. To guard against this, guidance was provided on the checklists about the meaning of the different terms in the DPSIR model, while each checklist was checked by one person responsible for the work overall.

BOX 1
Permanent swamps, Illubabor, Ethiopia

Drivers:

- a) population growth and land shortages – often linked to upland degradation;
- b) food insecurity – owing to pests and crop storage problems;
- c) land shortages for cultivation and grazing owing to coffee planting on uplands;
- d) land reform in 1975 (equal access to all land types including wetlands) – giving more people access to wetlands and encouraging use;
- e) government policy and task force to improve national food security by drainage agriculture;
- f) in-migration owing to land degradation in north leading to resettlement and land allocations;
- g) local market for food in coffee towns.

Pressures:

- a)–g) drainage and cultivation in wetlands;
- b) double-cropping of some wetlands (intensification);
- a) and c) sediment deposition from uplands associated with upland degradation;
- d) uncontrolled and heavy grazing by cattle in wetlands.

State:

- a)–g) lowered water tables and increased soil acidity;
- b) soil nutrient decline and soil structure changes with prolonged low water table;
- c) decline in soil quality at fringes of wetland owing to upland sediment deposition;
- c) and d) soil compaction;
- a)–f) destruction of the wetland vegetation;
- a)–f) biodiversity in wetlands increased owing to more diverse, especially non-wetland, conditions.

Impacts:

- b) food security improved, but not for all households, some through cultivation and some through piece work – on wetland farms;
- d) some upper-middle-income farmers are gaining at the expense of others in the community who traditionally use wetlands for local uses, e.g. women for water collection, poor men for reed harvesting;
- a)–g) springs drying up and women having to walk further to obtain domestic water supplies;
- d) tensions between different user groups in a few cases;
- c) forage resources enhanced where wetlands partially drained;
- e) recognition of value of wetlands in government and more widely in communities;
- g) urban food supply improved.

Responses:

- at driver level:
  - e) NGO action to reduce demands of wetland task force through training on the dynamics of wetlands and the impacts of double-cropping and intensive wetland use;
- at pressure level:
  - a)–d) development of community-based institutions to manage wetlands;
  - a)–d) development of local guidelines for the selection of wetlands for agriculture;
- at the state level:
  - a)–d) use of community-developed techniques, such as ditch blocking, to assist in maintaining water table level;
  - a)–d) farmer experimentation on land management and multiple land use;
  - a)–d) rules to protect springs.

Database, coding and analysis

In order to analyse the cases, a database was created and a coding regime developed to prepare the cases for entry. This coding was based initially on the words and terminology used in the checklists that were drawn directly from the source documents. It was developed in various iterations as the number of case studies built up. This involved both adding more detail as the experience diversified and consolidating that diversity into groups to facilitate analysis. The final categories used for coding the DPSIR experience are shown in Annex 3. In order to maintain rigour and reduce the variability in this process, it was undertaken by one person.

Once the coding had been completed and the checklists entered into the database, a series of interrogations of the database were undertaken. These focused initially on the patterns of DPSIR variables by the major groupings of the cases (wetland type, Ramsar region, market orientation and water management). Some of these groupings were simplified to facilitate analysis.

REFLECTIONS

Using the DPSIR model was helpful. It provided rigour in the analysis of a range of cases with different levels of documentation and detail, and forced this diverse body of information into a form that allowed comparison. This is particularly important given the variations in the data outlined in this chapter and the diversity of experience referred to in Chapter 1. The main area where the model did not work particularly well was when it was applied to cases of apparent sustainability and stability in AWIs, as these do not appear to have current drivers and pressures leading to current state changes. Overall, a balance had to be struck between using the DPSIR model, the checklist and the coding rigorously to ensure comparability, and allowing a degree of flexibility to include the range of cases identified with their varying data availability.