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THE ICID ENVIRONMENTAL CHECK-LIST

To Identify Environmental Effects of Irrigation, Drainage and Flood Control Projects

INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE

HR Wallingford

ODA

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SUMMARY

The Working Group established by the International Commission on Irrigation and Drainage to investigate the environmental impacts of irrigation, drainage and flood control projects has produced this Environmental Check-list to help identify possible environmental changes which such projects may bring. Effects are grouped under eight topic areas: hydrology, pollution, soils, sediments, ecology, socio-economic, (human) health and (ecological) imbalances.

The Checklist forms the framework for a procedure for identifying environmental effects of new or existing projects intended for use by engineers and planners who are not specialists in the environmental sciences. The procedure comprises two sets of Data Sheets, one for recording general project information and the other for more specialised data, a set of Detailed Descriptions and Related Reference to assist understanding of each item on the Check-list, a Look-up Table to indicate which information in the Data Sheets is relevant to which Check-list item and a Results Sheet to help the user assess possible positive and negative changes and areas where further data and expertise are needed.

Practical guidance is given in the use of the Check-list procedure in various localities and for various types of project and suggestions are given as to how it might be adapted to specific situations. The main components of the procedure are given in a form which can be photocopied for field use.

Through use of the Check-list it is hoped that irrigation/drainage engineers and planners will become more involved in assessing environmental change and mitigating against adverse impacts. The Check-list will enable specialist expertise to be used more effectively and will promote closer cooperation between specialists and non-specialists in the development of environmentally sustainable projects.

The support of the UK Overseas Development Administration in providing funding for the Check-List is gratefully acknowledged.

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1 Background

1.1 Environmental issues in irrigation, drainage and flood control

Irrigation, drainage and flood control projects and their dams are designed and constructed for the benefit and well-being of people. The world food supply today is unthinkable without these projects. Although only about 20% of cultivated land is irrigated, about 50% of agriculture production is raised there. It cannot be denied, that in the past two centuries of rural development the main attention was directed towards increased agricultural production without adequate regard to associated environmental changes. Only recently have people realised that an intact environment is of equal importance for the sustained well-being of people as well as for sustainable projects. Therefore, a much more complex integrating approach to project planning is developing, which not only considers the production side but also the betterment of the overall environment and the minimizing of unavoidable environmental disadvantages.

Examples of the damage caused by unforeseen 'environmental impacts' of irrigation, drainage or flood control developments are numerous and have been reported from a wide range of geographic, climatic and social conditions around the globe. They include both impacts which affect the performance of the irrigation/drainage works themselves and those which damage the wider environment. In some cases, remedial actions intended to alleviate problems caused by one type of impact have led, in time, to others. For example, high water tables and waterlogging caused by over-irrigation and by the seepage of surface irrigation water from canals have been reversed, in some regions, by a switch to irrigation from groundwater. This, in time, has led to a decline in irrigated production due to severe depression of the water table and gradual pollution of the groundwater through infiltration of saline and polluted drainage water. Such examples demonstrate the complexity and dynamic nature of environmental changes.

The complexity of environmental processes and systems is such that accurate prediction of the full spectrum of changes brought about by a particular human activity is not generally possible. However, knowledge and awareness are increasing. Many of the mistakes made in the past can now be avoided and planning can be oriented from the beginning toward environmental improvement. A growing sensitivity to environmental effects will be needed if the increasing manipulation of the natural environment for irrigated food production, land reclamation and flood protection, for the benefit of an expanding human population, is to be sustainable into the future.

In this brief introduction it is not possible to discuss in full the many complex issues raised in the debate about social and economic development and environmental sustainability. Nevertheless, it is necessary to define a number of the terms which will be used in this report so that the reader is not confused as to the intended meaning. This may involve opting for particular meanings or usages which are under debate or which others may use differently.

- Environment and Environmental are used in their broadest possible sense to include not only physical and biological systems but also social and economic systems and relationships.

- Environmental impacts and effects are taken to include both the influence of the wider environment on a project and the influence of the project on the environment. They are also taken to include both 'positive' and 'negative' changes.

- A Project is defined as a specific set of human activities in a particular location intended to modify the environment for human benefit. Using the above definitions, a Project's prime aim is to maximize environmental enhancement while minimizing environmental change. (Further discussion of the definition of a Project in relation to the use of the Check-list is contained in Section 3.2.) In terms of the assessment of environmental change it includes not only the direct works of the project but also the indirect changes in infrastructure and population associated with it.

- Irrigation/drainage Planner, Manager, Engineer and Professional are terms used to describe those people who, by virtue of their specific technical training in the techniques of irrigation, drainage and flood control, are given responsibility for planning, designing, implementing and managing irrigation, drainage and flood control projects. Use of these terms is not intended to be restrictive in relation to the disciplines or training which such people have received but relates to their assigned responsibilities and functions in a given situation.

1.2 Current approaches and priorities in environmental assessment

The initial impetus to introduce methods of environmental assessment was provided by growing public concern about the large number of unforeseen, adverse environmental impacts which were reported during the 1960s and 1970s due to new development projects particularly those constructed in areas where little previous infrastructure development had taken place. As a result, many countries have now adopted formalised (and statutory) procedures for environmental impact assessment (EIA) to be applied to all new projects within specified categories. In almost every case, irrigation, drainage and flood control projects are included within the list of project types for which an EIA is normally required although in some countries projects smaller than a specified size may be exempt.

Whilst putting a useful check on projects which might otherwise have caused lasting environmental damage, the introduction of statutory EIA procedures is now acknowledged to have some significant shortcomings, the principal ones being:

(a) that EIA concentrates on negative aspects of environmental change and results in a situation of conflict between those who have planned a project and those who undertake the EIA on it;

(b) that due to the detailed information required and the number of specialists engaged in an EIA it is not usually undertaken until a late stage in project planning when changes to the project to mitigate adverse effects are difficult and costly;

(c) that dialogue between environmental specialists and project planners to identify beneficial modifications to the project design or concept is not facilitated by EIA;

(d) that available EIA procedures are too general in scope and require the user to exercise considerable knowledge and skill each time they are applied to projects of a particular type such as irrigation or drainage; and

(e) that EIA procedures are intended for use only by people with particular expertise in social and environmental impact assessment and overlook the potential savings in time and cost which could be achieved if non-specialists were to do some of the preliminary data collection as part of normal planning activities.

The procedure described in this report attempts to overcome some of the above difficulties.

1.3 Environmental awareness within the ICID

The International Commission on Irrigation and Drainage (ICID) is a non-governmental professional association drawing together the diverse disciplines and professions involved in the planning, design, operation and management of irrigation, drainage and flood control works throughout the world. The Commission provides a forum in which the technical, economic and managerial complexities involved in the development of irrigation, drainage and flood control can be discussed and in which improved practices can be identified and promoted. In 1986 the commission recognised the need to address environmental questions more directly and established an international Working Group on Environmental Impacts of Irrigation, Drainage and Flood Control Projects. The Working Group, which is taking an increasingly active role within the ICID, sees its purpose as being to educate the relevant professional groups, particularly within the engineering community, and enable them to play an active role in identifying and avoiding practices which would result in environmental degradation and identify the potential for environmental improvements. By seeking to enable practising professionals to make a positive contribution in the search for improved technologies which are more in harmony with the natural environment, the ICID is hoping to avoid the sterile conflicts which have developed over environmental issues in the past.

One of the main tasks which the ICID Environmental Impacts Working Group has been undertaking over the last three years is the drafting of a Check-list. The Check-list provides a comprehensive guide to the areas of environmental concern which should be considered in the planning, design, operation and management of irrigation, drainage and flood control projects.

The ICID Environmental Check-list was compiled from contributions received from experts from various national sections of the ICID. The material was edited into a common format and revised into the current form by the compilers assisted by comments on earlier drafts received from the Working Group members. In 1991 a final draft was circulated more widely (Mock and Bolton, 1991) for the purpose of allowing its trial use in different situations so that feedback could be received and modifications made before publication.

The present report, benefitting from this feedback, is of wider scope and more comprehensive than the earlier drafts.

2 The ICID Check-list

2.1 Purpose

The main purpose of the Check-list is to provide a tool which will enable specialists and non-specialists concerned with irrigation and drainage development to improve their knowledge and understanding of the environmental changes which such projects may bring so that adverse effects can be identified and, if possible, avoided or controlled and positive effects enhanced. Through its educational effect the Working Group believes that the Check-list will assist irrigation and drainage professionals, the majority of whom have little or no specialist environmental training, to play a greater role in the process of identifying and controlling adverse impacts and supporting environmental enhancement activities.

A second purpose of the Check-list is to adapt and simplify existing approaches to environmental assessment to meet particular needs and to make the most effective use of available resources. In this way assessments are made possible in situations where it would not be feasible to assemble the broad multi-disciplinary team necessary to undertake a conventional EIA, particularly at the project identification phase or in the initial stages of project planning.

The principal means to achieve the efficient use of resources is to define more clearly those aspects of an assessment which must be performed by environmental specialists and those which can be accomplished by non-specialists. This allows the available environmental or other specialist expertise to be used most effectively. Clarifying the roles of specialists and non-specialists is, therefore, a third aim of the Check-list.

A fourth aim is to bring together expertise from a wide range of sources concerning the environmental changes which relate to a specific group of projects: irrigation drainage and flood control projects and their dams. This allows a comprehensive framework to be established ensuring that no aspects are overlooked. Such a framework can either be used unchanged or be adapted by local experts to suit a particular application.

Finally, the ICID Check-list has been developed with a view to its practical application so that the outcome from its use is not a judgement on the project which may lead to conflict and inaction but a series of recommendations which may be used to define further information needs and areas requiring closer study. These recommendations can then be acted upon as resources become available and more detailed decisions concerning various aspects of the project are made.

2.2 Description

The term "Check-list" may be misleading since it suggests a single list or table. The contents of this report are structured around such a table (Table 1) but the report includes other components which together form the basis for an assessment procedure. The various components and their relationship to each other are shown in Figure 1. A brief description of the components and their location in this report is given below. Some important components are included as Appendices to the report so that they do not interrupt the flow of the text and so that they can be readily located and photocopied for field use.

The Check-list - Summary Table: In its simplest form the Check-list is a list of those environmental effects which must be considered in relation to irrigation, drainage and flood control projects and their dams. The list, presented in Table 1, categorises the different effects under eight headings: hydrology, pollution, soils, sediments, ecology, socioeconomic, (human) health and (ecological) imbalances. The selection of which items to include in the Check-list was based on a wide review of the literature and on submissions to the Working Group by various experts.

The Check-list - Detailed Descriptions: Detailed descriptions have been prepared to define the scope of each Check-list item. These descriptions are given in Appendix 1. Under each description a space has been provided so that observations can be recorded during an assessment on copies of Appendix 1. Because of the possible overlap between the scope of some items and the dependence of some items on changes described under other items, a matrix is provided (Table A1.1) which shows the linkages between items.

Related References: A selected list of references is included in Appendix 2 related to each item of the Check-list. The references have been chosen to provide the non-specialist reader who already has a broad scientific or technical education with an introduction to the nature and causes of each item in the Check-list and details of available mitigating measures.

General Data Sheets: Two types of data sheet are provided to enable the user to systematically collect and record data and information from a specific project which will be relevant to the assessment of environmental effects. The General Data Sheets are given in Appendix 3 and are intended, particularly, for use by irrigation/drainage professionals. The data they contain are largely of a non-specialist nature of the type that would normally be used by irrigation/drainage professionals in planning or managing any irrigation drainage or flood control project. Such data may relate to a large number of different types of environmental change.

Table 1 The ICID check-list of possible environmental impacts of irrigation, drainage and flood control projects

Hydrology	1-1 Low flow regime	
	1-2 Flood regime	
	1-3 Operation of dams	
	1-4 Fall of water table	
	1-5 Rise of water table	
Pollution	2-1 Solute dispersion	
	2-2 Toxic substances	
	2-3 Organic pollution	
	2-4 Anaerobic effects	
	2-5 Gas emissions	
Soils	3-1 Soil salinity	
	3-2 Soil properties	
	3-3 Saline groundwater	
	3-4 Saline drainage	
	3-5 Saline intrusion	
Sediments	4-1 Local erosion	
	4-2 Hinterland effect	
	4-3 River morphology	
	4-4 Channel structures	
	4-5 Sedimentation	
	4-6 Estuary erosion	
Ecology	5-1 Project lands	
	5-2 Water bodies	
	5-3 Surrounding area	
	5-4 Valleys & shores	
	5-5 Wetlands & plains	
	5-6 Rare species	
	5-7 Animal migration	
	5-8 Natural industry	
Socio-economic	6-1 Population change	
	6-2 Income & amenity	
	6-3 Human migration	
	6-4 Resettlement	
	6-5 Women's role	
	6-6 Minority groups	
	6-7 Sites of value	
	6-8 Regional effects	
	6-9 User involvement	
	6-10 Recreation	
Health	7-1 Water & sanitation	
	7-2 Habitation	
	7-3 Health services	
	7-4 Nutrition	
	7-5 Relocation effect	
	7-6 Disease ecology	
	7-7 Disease hosts	
	7-8 Disease control	
	7-9 Other hazards	
Imbalances	8-1 Pests & weeds	
	8-2 Animal diseases	
	8-3 Aquatic weeds	
	8-4 Structural damage	
	8-5 Animal imbalances	

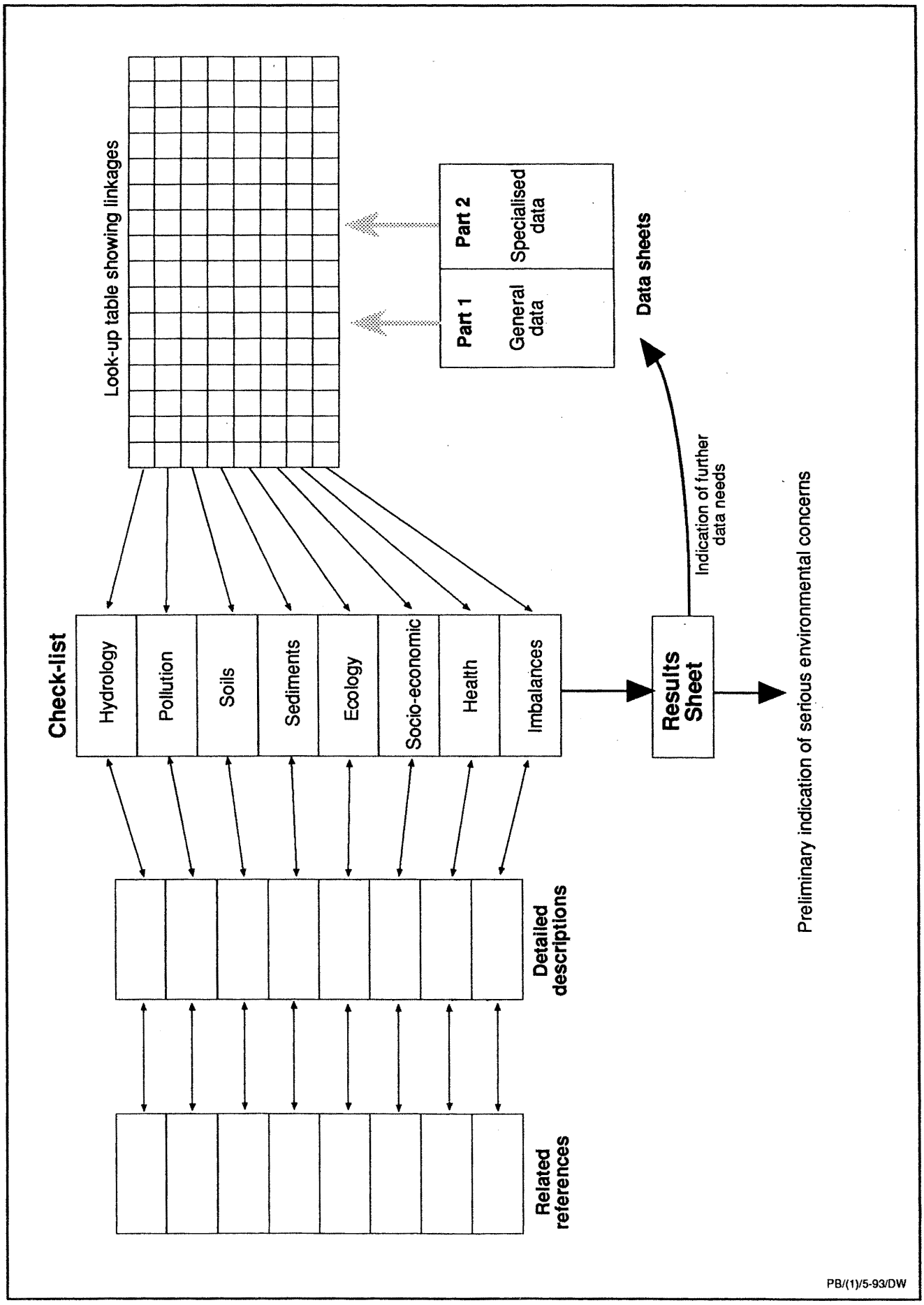

Figure 1 Components of the Check-list assessment procedure

Specialised Data Sheets: The second set of data sheets, given in Appendix 4, contains types of data which would not routinely be collected for the planning or operation of an irrigation, drainage or flood control project. Such data would normally only be found in specialist reports or would have to be collected separately by an expert. The sheets are grouped under headings which relate to a fairly narrow range of environmental effects. The name 'Specialised Data Sheets' refers to the probable source of data rather than to the person whose job it is to enter the data. A non-specialist may complete the sheets provided he/she has access to relevant specialist reports.

Look-up Table Showing Linkages: Appendix 5 contains a look-up table which shows which items of data collected in the data sheets are relevant to which environmental effects listed in the Check-list. This is an important tool for a non-specialist helping him/her to focus on the data most relevant to a particular environmental effect and to assess whether key items of data are likely to be missing.

Results Sheet: Using all the components described above the user is guided in making an assessment using the assessment sheet in Table 2. The use of this sheet is described in detail in Section 3.5 below.

2.3 Scope

In developing the Check-list the Working Group chose to focus on the pre-feasibility planning phase for new developments or rehabilitation projects. This focus shaped the form of the various components of the assessment procedure based around the Check-list. However, it was soon realised that a necessary feature of the material would be its adaptability to other applications for example, as the basis for a post hoc evaluation of an existing project; or to guide an environmental scientist in planning a formal Environmental Impact Assessment. Further discussion of possible adaptations to the Check-list and the means to achieve them is contained in Chapter 4.

The important characteristics of pre-feasibility study planning which prompted and shaped the format of this Check-list are:

(i) Fundamental choices are made about the scope of a proposed project which may have a profound influence over the environmental impact of the project and which become increasingly difficult or costly to modify as the planning process proceeds.

(ii) Data sources are limited and data gathering is costly in relation to the budget available at this stage in the planning process. Maximum use must be made of available data and important data gaps must be identified.

(iii) Budget constraints also limit the extent to which professional expertise over a wide range of disciplines can be consulted. Again, the maximum use must be made of available expertise and important gaps identified so that the relevant expertise can be sought at a later stage.

The use of the Check-list should not be regarded as providing an absolute measure of environmental risk. Nor should it be used as a substitute for an Environmental Impact Assessment where these are required under the normal procedure of project preparation. However, if the Check-list has been applied at the pre-feasibility stage, it is anticipated that early action will be taken to remove from the project, or compensates for, the features which may result in the most serious environmental impacts before a formal Environmental Impact Assessment is carried out. This will mitigate the potential conflicts of interest which often arise. The Check-list will also assist those subsequently undertaking the Environmental Impact Assessment, as noted above, by providing a framework for their work.

Although the General Data Sheets draw on material contained in normal project reports they cannot provide a substitute for such reports. A number of important aspects of project planning are not covered by the Data Sheets; for example, they do not contain data relating to the economic viability of a project.

The Check-list and Data Sheets have been written in as general a format as possible so that they can be used with irrigation, drainage, land reclamation and flood protection projects and their dams. They are also formulated in such a way that the data can be recorded either where there is an existing scheme (for which an evaluation is required or which is due to be rehabilitated or extended) or for a totally new development which is being planned.

The Working Group saw the Check-list as being of greatest value in tropical and sub-tropical regions where environmental changes tend to be most diverse and far-reaching and where data are often sparse. Nevertheless, the possible environmental effects of projects in temperate regions were also considered and these have been included in the drafting of the Check-list.

Where projects depend on the creation or changed operation of large multi-purpose reservoirs the full environmental effects may not adequately be addressed by use of this Check-list. Large reservoirs can cause significant environmental impacts the full extent of which can only be assessed by a detailed study which takes account of the effect of various patterns of water use on the water level and discharges from the reservoir. The environmental effects of large multi-purpose dams have been considered separately by the International Commission on Large Dams (ICOLD, 1982) but for smaller impoundments or for single purpose reservoirs linked to an irrigation, drainage and flood control project this Check-list may be adequate.

3 Directions for use

3.1 Introduction

As stated in Section 2.3 the Check-list and Data Sheets are intended to be comprehensive, but simplified or adapted versions may be developed by the user for particular types of project and geographical regions as described in Chapter 4. Unless a version is available which has been specifically adapted to a particular local

application, the user is strongly advised to work from the complete versions of the Check-list and Data Sheets as given in this report. This will entail ignoring, for the time-being, those parts which are not relevant.

Readers may use multiple copies of information in Tables 1 and 2 and Appendices 1, 3 and 4 in the format presented to undertake project assessments. However, in any subsequent publication of the results, acknowledgement should be made of the ICID and to the title, date and publication details of this report. Equivalent tables and data sheets from earlier drafts of the work are no longer valid and should not be used. A version in French of this report is being prepared.

3.2 Definition of the Project

The first task which must be undertaken by users of the Check-list is to define the 'Project' on which it is to be applied. When used in the sense described below 'Project' is written with a capital letter. The term is applied in the Check-list in the sense used by funding organisations: being the infrastructure, works and geographical boundaries within which a defined activity is taking place. Examples include:

- an entirely new irrigation, drainage or flood control scheme;
- the expansion of an existing scheme; or
- the rehabilitation of an existing scheme;

Since the Check-list can be used where no change to physical works is taking place the 'Project' can also be an existing scheme for which a post hoc evaluation is required un-related to any future developments.

Where schemes have been or are being developed in a number of separate phases, it may be appropriate to apply the Check-list separately to each phase. In this situation each phase will be regarded in turn as the 'Project' during the course of the investigation.

As noted in Section 1.1 the Project assessment includes all changes brought about either directly or indirectly by the planned works. Thus, population and infrastructure changes over a wide area should be included if they result from, or are required for, the Project. These include changes to roads, railway lines, telephone and power lines, towns and settlements.

In defining the 'Project' the user is advised to identify particular points in time as pre-Project and post-Project to avoid any confusion in the recording of data (see, for example, questions S3.5 and S3.6 in the Data Sheets).

Summary details of the Project should be recorded on the Cover Sheet of the General Data Sheets (Appendix 3) before proceeding further with the assessment.

3.3 General directions for use

Whether the 'Project' under study is a new project, an existing project or a proposal to expand or rehabilitate an existing project, the starting point for an evaluation using the ICID Check-list is the 'Detailed descriptions and record of findings' contained in Appendix 1 which defines the scope of each possible area of environmental change and allows observations and findings to be recorded. Use of Appendix 1 ensures that there is no misunderstanding about which environmental changes are to be considered under each item and that possible linkages and overlaps between different items are brought to the user's attention by means of Table A1.1. The remainder of Chapter 3 is written based on the assumption that the primary use of the Check-list is for the assessment of plans for a new project. Particular requirements which arise in assessing existing projects or modifications to existing projects are discussed in Sections 4.1 and 4.2.

Appendix 1 can be used in a variety of ways, for example:

- As an educational tool: It can be used as the focus for round-table discussion of general issues at a Workshop attended by specialists of different environmental disciplines and non-specialists.

- As a guide for formulating an appropriate assessment procedure: A team of specialists could use it to help them identify from their experience the likely issues of importance in any Project and from these develop an appropriate data collection and assessment procedure (or EIA) specific to the particular Project.

- As the core of an assessment using the ICID Data Sheets: This is the main use envisaged in this report and is explained in more detail below.

In each of the first two cases Appendix 1 may be used in isolation. In the third case, the value of any findings recorded in Appendix 1 will depend heavily on two factors:

(i) the amount and quality of any data which may be available; and
(ii) the expertise available for interpretation of the data.

With regard to data availability, there is much that a non-specialist can do in assembling relevant data from various sources. The Data Sheets in Appendices 3 and 4 are provided to give a format for recording such data. In any situation where an objective assessment is being made it is necessary to enter data into the Data Sheets before attempting to record 'Findings' in Appendix 1. Use of the Data Sheets is explained in Section 3.4.

The type of findings which will eventually be entered in Appendix 1 will be of a descriptive nature. They may include observations about the relevance of particular types of effect to the specific Project under study, about the adequacy of the available data or about the likely severity of any impacts. To assist the user in assessing the overall level of knowledge and the scale of impact of each item in the Check-list, a separate assessment sheet has been produced (Table 2) which may be used in

conjunction with Appendix 1. The processing of information in the Data Sheets to reach conclusions which can be entered into Appendix 1 or into Table 2 is explained in Section 3.5 below.

3.4 The Data Sheets

It is recommended that users begin a Project assessment by completing the Data Sheets in Appendices 3 and 4. However in the initial stage only data which are readily available should be entered. No new data should be gathered until existing data are compiled. This will result in a large number of gaps or partial answers particularly in the Specialised Data Sheets (Appendix 4). At the end of each chapter of the Data Sheets there is an open question allowing the user to record additional information and to list the sources of the data collected. This reference list will be of immense benefit as the assessment proceeds. It may include the names of local specialists consulted as well as published material.

Following this initial data entry, the user should undertake an initial assessment of the Check-list items as described in Section 3.5 below. This will indicate the significance of the data gaps in relation to particular impacts and enable the user to decide which missing data items are the most important and whether these can be filled by a field study within the resources and time available.

Further data collection may involve the user in a significant expenditure of time and resources. Specialist data collection programmes should be planned, if possible, with advice from appropriate experts and within an overall framework of priorities determined by the initial Check-list assessment. If the assessment is being made as part of the planning procedure for a future project, one of the main outputs being sought from the assessment should be a clear recommendation concerning the principal data items which are missing but which will be required at a later stage in the planning process if an indication of the full spectrum of environmental changes is to be provided, see Section 5.2.

If resources allow additional data collection during the course of an assessment, these data may be added to the Data Sheets and a new evaluation made of the significance of relevant items of the Check-list. When further data collection and re-assessment of the effects takes place, a clear record of each phase in the assessment process should be kept on the Cover Sheet for the Project (Appendix 1).

3.5 Framework for presentation of results

The Check-list and Data Sheets in this report provide a framework for collecting and organising the information necessary to indicate possible environmental changes, but do not provide the expertise on which the interpretation must be based. A user who does not have specialist training in the environmental sciences may require assistance from relevant experts in some areas with which he/she is unfamiliar. The user is strongly warned against attempting an interpretation in areas of the Check-list for which he/she has insufficient expertise, since an ill-informed judgement that a

particular impact is unimportant may deflect future attention away from an effect which may, in reality, have considerable impact on the project or region.

The recommended approach to assessing the effects listed in the Check-list, once all readily available information has been entered into the Data Sheets, is for the user to study side-by-side the Detailed Descriptions (Appendix 1), the Data Sheets (Appendices 3 and 4), the Results Sheet (Table 2) and the Look-up Table (Appendix 5). Each item on the Check-list must be considered separately. Although it is not necessary to work through them in the order given, there are strong linkages between items in the first four categories (Hydrology, Pollution, Soils and Sediments) and items below them in the Check-list. There are, therefore, advantages in addressing the first four categories first. For the user who has not before made an assessment using the ICID Check-list it is probably best to begin with one of the categories with which he/she is most familiar.

For each Check-list item the recommended procedure is first to read its Detailed Description (and possibly also those of any items shown to be closely linked to it in Table A1.1) so that a clear idea of the scope of the environmental effect is gained. If the user does not understand the scope of any particular item from the Detailed Description a cross (x) should be entered in column F of the Results Sheet together with a comment 'scope not understood' in the comments column. The user should then move to the next item.

When a Detailed Description has been adequately understood the user should begin assessing the environmental effects using whatever data are available and on the basis of his/her experience. The Look-up Table (Appendix 5) has been provided to guide the user as to which questions in the Data Sheets are likely to be most relevant in the assessment of each of the Check-list items. The Look-up Table not only shows which questions should be studied in assessing each item, but also indicates if the data are likely to be 'relevant', 'important' or 'very important'. If, for a particular Check-list item, no data have been found under a significant number of the questions identified as 'very important', it is unlikely that an assessment can be made on that item and a cross (x) should be entered in column F of the Results Sheet with the comment 'more data needed' entered. Further details of the additional data that would be required before an assessment should be attempted can be entered in the space marked 'Findings' under the relevant item in Appendix 1.

The other situation in which a cross should be placed in column F of the Results Sheet is when the user has collected a sufficient amount of data in the Data Sheets but does not have the expertise necessary to make an assessment of the significance of these data. In this case a comment 'expert help needed' should be entered in the comments column in addition to marking column F.

In all cases other than the three described above the user should make an initial assessment of the available data based on his/her expertise. For each environmental effect a cross (x) should be entered in one of the columns A to E to indicate one of the following: positive impact very likely; positive impact possible; no impact likely;

Table 2 Results sheet for assessing the ICID check-list

Project name/location: ..... ***Assessment: 1st/2nd/...*** .....

Assessor's name/position: ..... ***Date:*** .....

	For each environmental effect place a cross (X) in one of the columns	Positive impact very likely	Positive impact possible	No impact likely	Negative impact possible	Negative impact very likely	No judgement possible at present	Comments
		A	B	C	D	E	F	
Hydrology	1-1 Low flow regime							
	1-2 Flood regime							
	1-3 Operation of dams							
	1-4 Fall of water table							
	1-5 Rise of water table							
Pollution	2-1 Solute dispersion							
	2-2 Toxic substances							
	2-3 Organic pollution							
	2-4 Anaerobic effects							
	2-5 Gas emissions							
Soils	3-1 Soil salinity							
	3-2 Soil properties							
	3-3 Saline groundwater							
	3-4 Saline drainage							
	3-5 Saline intrusion							
Sediments	4-1 Local erosion							
	4-2 Hinterland effect							
	4-3 River morphology							
	4-4 Channel regime							
	4-5 Sedimentation							
	4-6 Estuary erosion							
Ecology	5-1 Project lands							
	5-2 Water bodies							
	5-3 Surrounding area							
	5-4 Valleys & shores							
	5-5 Wetlands & plains							
	5-6 Rare species							
	5-7 Animal migration							
	5-8 Natural industry							
Socio-economic	6-1 Population change							
	6-2 Income & amenity							
	6-3 Human migration							
	6-4 Resettlement							
	6-5 Women's role							
	6-6 Minority groups							
	6-7 Sites of value							
	6-8 Regional effects							
	6-9 User involvement							
	6-10 Recreation							
Health	7-1 Water & sanitation							
	7-2 Habitation							
	7-3 Health services							
	7-4 Nutrition							
	7-5 Relocation effect							
	7-6 Disease ecology							
	7-7 Disease hosts							
	7-8 Disease control							
	7-9 Other hazards							
Imbalances	8-1 Pests & weeds							
	8-2 Animal diseases							
	8-3 Aquatic weeds							
	8-4 Structural damage							
	8-5 Animal imbalances							
	Number of crosses							**(Total = 53)**

negative impact possible; and negative impact very likely. Further details of the type of impact expected, the time-scale involved (eg short-term, immediate, permanent) as well as the cause of the impact should be entered in Appendix 1 under 'Findings'. In some cases there may be both positive and negative impacts which might occur under a single Check-list item. In such cases a cross (x) may be entered in column A or B as well as in column D or E and a comment 'positive and negative impacts' entered in the comments column. However, if it is clear that the positive impacts outweigh the negative or vice-versa a single column should be marked on the Results Sheet. It should be noted that the number of occasions when two crosses are marked against a single item is likely to be very few and is limited to the situations when both positive and negative changes are expected. The use of two or more crosses should not be allowed as a way of indicating uncertainty or indecision on the part of the user.

When the assessment is complete the number of crosses in each column should be summed to give an indication of the number of responses in each category. However, these numbers should not be given strict quantitative significance in assessing the overall balance of positive and negative changes resulting from the project since certain changes will be far more significant than others. Interpretation of the Results Sheet will be discussed further in Chapter 5.

4 Adapting the Check-list to specific applications

4.1 Evaluation of existing projects

There are various reasons why an evaluation of an existing project may be required. Increasingly, international funding agencies are recognising the need to undertake evaluations, five or ten years after implementation, of projects which they have funded. Such evaluations are generally broad in scope, concentrating particularly on the physical and economic performance of the project, but most evaluations also include a requirement for an environmental assessment in their terms of reference. Similar evaluations are sometimes required by a government department, covering a number of existing projects of different ages, in order to provide the department with a picture of the physical and economic status of, say, irrigation or land reclamation works in a specific region. The information collected is then used to guide future operations, maintenance and investment policies. Finally, evaluations may be made for research purposes. A particular need at present is for well researched case studies to be undertaken into the full environmental impact of specific projects whose implementation history is documented. Such case study material is necessary both for educational purposes and to enable more realistic assessments of environmental costs to be made in the planning of future projects.

Depending on the specific objective of the evaluation and the resources available, a method of data collection and interpretation must be evolved which provides as much relevant information as possible. In some cases a large budget may be available allowing a multi-disciplinary team of experts to be assembled. In such cases, the Check-list will find a role mainly as a means of dividing responsibilities amongst the team and ensuring that all possible impacts are considered.

Where a much smaller budget is available, however, preparatory work may have to be undertaken by a non-specialist who will attempt to identify where the most significant changes have occurred on the basis of readily available data. In such cases the procedure for data collection and interpretation will be similar to that described above for new projects. The principal difference will be that environmental changes as a result of the Project will have already taken place or will be in the process of taking place so that direct observations are likely to provide the most relevant information (mostly shown by a black circle in Appendix 5). Therefore the collection of indirect information (mostly items shown by shaded or open circles in Appendix 5) is less important except to show the possible causes of observed changes.

In evaluating existing projects, local inhabitants and officials (Project managers, irrigation supervisors, village heads, health officials, development/aid workers) should be consulted and their observations or opinions recorded against relevant items of the Data Sheets or Check-list. Very often the opinions of local people about the performance and impacts of a project will provide valuable guidance to the non-specialist in identifying areas to which particular attention should be addressed. Nevertheless, opinions can sometimes be misleading and users of the Check-list are advised to verify them with data and direct observation wherever possible.

In order to record the additional information obtained through interviews with local inhabitants and officials it may be advisable to prepare a modified version of the Data Sheets with spaces for such observations to be recorded. Adaptation of the Data Sheets in this way would be particularly worthwhile where a large number of existing projects are being studied. An adaptation of this type is described by Bolton et al (1991).

4.2 Rehabilitation, modernisation or extension of existing projects

The rehabilitation, modernisation or extension of a project normally requires the planner to undertake two assessments: one, an evaluation of the existing project; and two, a prediction about the future effects of the plans being proposed. In terms of these assessments the first may be treated as described above for existing projects (Section 4.1) and the latter treated in the same way as for new projects (Sections 3.3-3.5). Much of the data collected will be common to both assessments but differences will arise where:

- the questions in the Data Sheets relate to an observed or predicted change (as in S3.5 and S3.6). For the first assessment the period under study is from the date when the scheme was implemented until the present, whilst for the second it is between the present and some future date after implementation of the rehabilitation/extension works;

- an extension is being proposed in which case the land area, and therefore the area of influence of the scheme, will increase;

- a change in system characteristics or in cultivation or management practices is being proposed as, for example, in the case of an irrigation scheme, where drainage works are being introduced for the first time.

Rehabilitation projects should be studied with particular care. The fact that rehabilitation is taking place indicates that the scheme is performing below design expectations. In such cases the user of the Check-list must ensure that the information obtained in the Data Sheets and through interviews with local people, as described above in Section 4.1, clearly identifies the causes of this poor performance. In reality, it is unlikely that a single cause will be found. Poor performance may arise from a combination of physical factors (such as deteriorating construction materials), operational factors (such as lack of farmer credit or an unsuitable fee collection mechanism), institutional factors (such as conflicting responsibilities between various organisations or groups), social factors (such as inappropriate mechanisms for farmer participation) as well as the environmental factors covered by the Check-list. Most of these factors relate in one way or another to particular sections of the Data Sheets but it will be necessary to record additional information in certain areas if the reasons for poor performance are to be fully understood. Comprehensive Guidelines for assessing the factors affecting irrigation performance are given by Bottrall (1981). As with the analysis of existing projects, preparation of an adapted version of the Data Sheets to include information relating to the reasons for past poor performance of projects may be worthwhile especially where several such assessments are being undertaken in a region.

4.3 Specific types of project

It is intended that the Check-list and Data Sheets are as comprehensive as possible within their stated purpose and scope. As a result users may find certain items have little significance when applied to particular projects or geographical regions. It is hoped that where the users of the Check-list wish to apply it on a routine basis to a particular type of project in a specific region, they will seek specialist advise in simplifying the material and adapting it to the given situation. For example, an agency which is responsible for drainage or land reclamation projects but not for irrigation may adapt the Check-list and Data Sheets so that questions relating specifically to irrigation are removed.

A particular problem may arise in attempting to apply the Check-list to small projects since the amount of data which must be collected may be out of all proportion to the resources available to the planning authority. In such situations a simplification of the Check-list and Data Sheets may be attempted. However, planners should be aware that small projects are rarely undertaken in isolation: they tend either to be part of a wider programme of irrigation development planned for the region through a series of small schemes or to be the pilot project for a large project planned for the future. Where this is the case, the Check-list may be used with respect to the group of projects, to the development of the defined region, or to the larger project which will follow if the pilot project is successful.

For a region in which numerous small projects are planned, once an overall assessment has been made of the wider impact of the planned development of the region, a simplified assessment could be developed from the Check-list to ensure that selected key issues are addressed further as each small project is implemented.

4.4 Specific locations

Adaptation of the Check-list and Data Sheets for use in specific locations is also feasible on the basis of local expertise and experience. For example, the section of the Data Sheets on human health contains lists of diseases some of which may not be relevant in a particular country or region. Consultation with local health officials may, therefore, allow the list to be simplified thereby ensuring that the user's attention is focused on those diseases which are of particular significance in the region. However, such simplification must be undertaken with care in regions where major environmental change is likely to result from projects being planned, since local experts may discount impacts which had not previously been encountered in the region.

An important way in which the Check-list and Data Sheets can be adapted for local use is to provide the user with guidance as to sources of local data, the names of responsible agencies and the translation of key words into local languages.

5 Interpretation and application of results

5.1 Identifying key issues

One of the principal ways in which the results are intended for use is in identifying those environmental effects which are likely to be the key issues in relation to the environmental impacts and sustainability of the Project, whether it is existing or planned. The framework for presenting results described in Section 3.5 and summarised in Table 2 is the basis for this assessment.

Clearly the key issues are those which are associated with adverse impacts, since the main objective of doing an environmental assessment is to identify ways in which adverse effects can be minimised. The categories in Table 2 are not sufficient by themselves to identify priority issues, since a mark in column E (negative impact very likely) will be recorded whether the impact affects only a limited area for a short period of time or a large area permanently.

A further step of assessing the significance of impacts is therefore necessary. This is described in Section 5.3 below. However, this step almost certainly requires the participation of experts from specific disciplines and the resources to employ them may not be immediately available.

It is recommended that whether or not the assessment can move forward to the stage of assigning significance to key impacts, the user should summarise the initial findings of potential negative impacts from Table 2. A separate list should be made of those

items which have been identified as leading to a 'possible' or 'very likely' negative impact. In pre-feasibility planning this list will then form the basis for recommending areas requiring particular specialist study in the next phase of project planning and design. If possible the list should give specific details of the nature, time-scale and likely severity of the impact drawing on the observations recorded under 'Findings' in Appendix 1.

Until an assessment of significance has been made it is not possible to evaluate the overall environmental impact of a Project, but the fact that a large number of items appears on the list of potential adverse effects should provide a warning to the user that environmental issues must be taken seriously and that resources may have to be found to support specialist studies over a wide range of disciplines. Unfortunately the opposite conclusion is not necessarily valid: if a few items appear in the list, environmental changes may still be highly significant for the project since a single item may have a significance which over-rides all other considerations. However, further investigations are facilitated when they can be concentrated on a few items.

In studies related to project identification or pre-feasibility planning for a new project, an indication from Table 2 that there may be a large number of adverse environmental changes, even without further information about their significance, should prompt the user to consider whether the fundamental form of the Project could be modified in any way to reduce these effects. It is far better to spend time considering a number of options at the early stages of project planning than to opt for a single solution and develop it to the detailed design stage only to find that environmental considerations make it impossible or unwise to implement.

Whenever other options are considered in this way separate Data Sheets, Findings and a separate Results Sheet should be completed for each option. A summary record should also be kept of the characteristics of the options being considered and why the user expected these changes to reduce adverse impacts.

5.2 Identifying data gaps

In any assessment, close attention should be given to items in the Results Sheet which have been marked under column F; "no assessment possible at present". As discussed in Section 3.5 there are three distinct situations which may cause a user to mark column F:

(a) scope of the effect is not understood by the user;

(b) more data are required to make an assessment; and

(c) expert help is required to assess the data.

The "comments" column should contain a note to help distinguish these situations. The response of one user will vary depending on the situation.

If the comment is 'scope not understood', where a user does not fully understand what is intended by the detailed description of a particular Check-list item he/she can do one of two things: either try to learn more about this area of environmental change by studying one or more of the references recommended under the item in Appendix 2; or ask an expert in the specialist area to explain the types of change intended for consideration under this item. The user should attempt to understand the scope of the particular item more fully rather than hand over this part of the assessment to an expert since unless the scope of each item is understood the user will not understand how particular items relate to each other or what potential there is for mitigating against adverse changes.

If the comment is 'more data needed', where there appear to be too few relevant data entered in the Data sheets, especially those shown in the Look-up Table to be "very important" to the particular item, the user should list what additional data should be collected in order for an assessment to be attempted. This should be done separately for each item. When the list is complete it should be used for planning further data collection either during the current phase or at a later stage in the development and assessment of the Project. It may be found that certain data could be collected easily and would assist in the interpretation of several environmental effects. In such cases the user may authorise their collection immediately. In other cases a balance has to be struck between the cost of collecting further data and the likely significant of the findings based on these data. This may not be judged easily by a non-specialist and expert advise may be required.

In all cases where items have been marked into column F through lack of data, a clear record of the fact must be made so that resources can be allocated to collect data at a later stage. If the number of items in this category is large, a large amount of resources will probably be needed for further data collection. This should take place before further effort is expended in developing the Project to a more advanced stage.

If the comment is 'expert help needed', the user sees the need for an expert to assist him/her to assess the data already collected. In some cases this lack of specialist knowledge can be overcome by reading suitable references such as those listed in Appendix 2. In other cases an expert may have to be consulted. If possible, it is preferable to take the Data Sheets to a local expert immediately and to discuss the particular item but this depends on the user knowing who to approach for such advise. Very often, universities or research institutions will help in this situation. Discussion between the user and the expert will be of considerable value in helping the user understand the causes and significance of particular adverse changes and identifying ways in which the adverse effects may be reduced or mitigated.

The need for additional data to provide a more complete assessment is not linked solely to items marked in column F. Columns B (positive impact possible) and D (negative impact possible) indicate uncertainty about particular environmental effects which may, in part, be due to lack of data. Therefore each item in these two columns should be studied to see whether further data collection might enable a more certain assessment to be made. A separate list of data needs for items under these columns should be made in the same way as for the 'more data needed' situation of column F.

To help plan further data collection, seeking additional data is less important for items in column B than those in column D.

There may also be items entered in columns B and D which are similar to the 'expert help needed' situation of column F. Additional expertise may enable a more conclusive result to be reached. In this case they may be treated in the same way as for column F but again greater priority should be given to items in column D especially those for which a significant adverse impact is possible.

When the user reconsiders items in column F and in columns B and D, as recommended above, it is likely that a number of changes to the Results Sheet will be possible. Items which were previously entered in column F may now be transferred to one of the other columns because new data or new understanding have allowed an assessment to be made. If such changes occur it is advisable to complete a fresh copy of the Results Sheet, headed '2nd Assessment' rather than modifying the earlier Results Sheet. The date and purpose of the second assessment should also be recorded on the Cover Sheet (Appendix 3). Subsequent re-assessments should also be made on separate sheets.

5.3 Assessing the significance of effects

The assessment of whether a positive or negative impact is possible or very likely is only the first step in judging the overall importance of the environmental changes brought about by a Project. The next step is to identify which changes are the most significant and to judge the overall impact of all the changes. This will normally require help from specialists of various disciplines.

Assessment of the importance of particular changes should start with a detailed study of each of the 'possible or 'very likely' negative impacts to assess whether the changes have such serious implications that they might, by themselves, be considered sufficient reason to abandon or substantially modify the Project. Changes of this type are sometimes named 'fatal flaws', when the impact seriously damages the performance of the Project itself, or 'fundamental impediments', when they relate to serious impacts of the Project on the wider environment. When a possible fatal flaw or fundamental impediment is identified, specialist help is needed to assess whether this judgement is correct and to assess whether there are ways in which the Project might be modified or mitigating measures introduced which would remove the need to condemn the Project.

The definition of what constitutes a fatal flaw or fundamental impediment is open to debate. It is closely linked to the debate about what may or may not be regarded as 'sustainable development'. For example, should a prediction that useful storage in a reservoir is likely to be substantially filled with sediment in 50 years be regarded as a fatal flaw in relation to an irrigation scheme depending on that supply of water? Should the fatal flaw judgement be removed if the sedimentation life can be increased to 150 years through controlled land use in the catchment? Ultimately these types of questions must be resolved at a political level but the irrigation/drainage professional has a duty to identify the issues clearly and to provide the best data and predictions

available on the scale of the effects. Hence, it is essential to record carefully any effects which may fall into these categories and to seek additional resources and expertise at an early stage to quantify the impacts more precisely. If no fatal flaws or fundamental impediments appear to exist, a wider assessment can be made of the overall significance of both positive and negative changes. Observations can be recorded against each Check-list item on a copy of Table 1.

It is unlikely that a single measure of significance will be available which would allow an entirely quantitative assessment of positive and negative effects. The Check-list comprises a very wide range of effects, from those which have direct economic implications (such as loss of productivity of agriculture), to those with an environmental value (such as disruption of breeding sites for birds), to those of a social or cultural nature (such as impaired health or loss of religious shrines). In some cases unambiguous indicators may exist which would allow direct comparison between impacts of the same type even though judgements concerning the overall significance of different types of environmental change will have to be made by a recognised political forum of some kind.

Another factor to record is the likely time-scale of the changes envisaged. How long will it take for the changes to take place and will they be temporary or permanent? To prepare a summary of the likely significance and time-scale of each effect it is again necessary to engage specialist help.

Once the indications of significance are complete an overall assessment of positive and negative changes may be attempted. However, this is not a matter to be addressed solely by professional groups. The relative importance of different types of impact is likely to lead to fairly open and wide debate for which the role of the professional is mainly to provide the best data and predictions available. It should be noted that the Check-list does not provide space to record the primary benefits of the Project (income, employment, food security etc) and these must also be considered in an overall assessment of the balance at positive and negative changes predicted.

5.4 Identifying mitigating measures

One of the chief aims of the ICID Environmental Check-list is to educate and involve professionals, who are not specialists in environmental sciences, in the process of assessing and minimising adverse environmental changes. This is particularly important with regard to proposing mitigating measures. Many adverse changes can be reduced by modifications to Project features by introducing special measures to counteract the effects of changes or by ensuring that appropriate compensatory measures are provided. The selection of suitable mitigating measures in each situation requires close cooperation between irrigation/drainage professionals and environmental specialists.

A copy of Table 1 may be used to record types of mitigating measures which might be effective in reducing the impacts identified in each stage of assessment as well as their likely cost. If measures appear to be viable and the costs can be met within the available budget, the Project may be modified so that certain mitigating measures are

included in the design. A re-assessment of environmental effects will then be required by completing a further copy of the Results Sheet. If insufficient details about the likely effectiveness and cost of proposed mitigating measures is available a list should be made for more detailed study at a later stage in the project development. This should also include an estimate of the time elapsing before measures are likely to become fully effective.

5.5 Establishing monitoring

In many cases the rate of environmental change caused by a Project may be slow and the eventual outcome difficult to predict. In such cases it may be more appropriate to monitor the changes regularly and to introduce mitigating measures or operational changes when the parameters being monitored reach a specified threshold. This is a common approach, for example, in relation to water quality and is valid provided that the parameters being monitored give warning sufficiently early for a corrective action to be taken.

As with mitigating measures, a copy of Table 1 can be used to record proposals for monitoring specific changes together with the likely costs of such monitoring. It should be noted, however, that the eventual costs of mitigation should be considered even where monitoring is recommended as the initial response to predicted adverse effects.

6 Definitions and Glossary

In order to use the Check-list and Data Sheets the reader may need guidance on a wide range of technical definitions and terms. Each of the references cited in Appendix 2 will provide such guidance in relation to particular subject areas. In addition, the ICID Working Group on Environmental Impacts is preparing a Glossary of Technical Terms related to Environmental Impacts and this will be made available as a separate publication.

7 Acknowledgements

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8 References

References related to particular Check-list items are given in Appendix 2.

The following references are cited in the main text:

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Appendix 1

ICID CHECK-LIST OF POSSIBLE ENVIRONMENTAL EFFECTS DETAILED DESCRIPTIONS AND RECORD OF FINDINGS

ICID CHECK-LIST OF POSSIBLE ENVIRONMENTAL EFFECTS
DETAILED DESCRIPTIONS AND RECORD OF FINDINGS

1. Hydrological changes

1.1 Low flow regime

Is the low flow regime of the river substantially changed by the Project and its dams (by more than ±20% in low flow periods)? If so, does this change benefit or impair aquatic ecosystems, existing or potential downstream abstractions, hydropower, navigation or recreational uses?

Findings:

1.2 Flood regime

Is the flood regime of the river (peak discharge and stage, speed of flood waves, flood super-position with joining rivers, duration or extent of floodplain inundations downstream) substantially changed by the Project as a result of changes in abstractions, retention storage, reservoir releases, flood protection works, new road/rail routes, river training or surface drainage works? If so, does this change benefit or impair aquatic and flood-affected ecosystems, lead to an increase or decrease in flood damage or change land use restrictions outside the Project?

Findings:

1.3 Operation of dams

Can modifications to the operation of any storage or flood retention reservoir(s) compensate for any adverse impacts associated with changes in flow regime, whilst minimising the losses to the Project and other users? Possible modifications affecting water quality downstream, saline intrusion, the sediment regime of channels, the ecology of affected areas, amenity values, disease transmission or aquatic weed growth should be considered. (A separate environmental assessment of large reservoir(s) may be required).

Findings:

1.4 Fall of water table

Does the Project cause a fall of the water table (from groundwater abstractions, reduced infiltration due to river training, drainage or flood protection works)? If so, does this fall lead to increased potential for groundwater recharge (from seasonal rainfall) and improved conditions for land use; or lead to depletion of the groundwater system, affecting wells, springs, river flows and wetlands?

Findings:

1.5 Rise of water table

Does the Project cause a rise of the water table (from increased infiltration or seepage from irrigation, seepage from reservoirs and canals, or increased floodplain inundation)? If so, does this rise lead to improved yield of wells and springs and improved capillary rise into the root zone; or lead to waterlogging of agricultural or other land in the Project area or vicinity?

Findings:

2. Organic and inorganic pollution

2.1 Solute dispersion

Are the Project and its dams leading to changes in the concentrations of organic or inorganic solutes in the surface water due to changes to the pattern of water abstraction and reuse in the basin or flow regulation? If so, do the changes benefit or impair biological communities or domestic, agricultural or industrial water users in the basin?

Findings:

2.2 Toxic substances

Are significant levels of toxic substances accumulating or being introduced, mobilised and transmitted due to the construction and operation of the Project and its dams, or are levels being reduced? Substances such as pesticides, herbicides, hydrogen sulphide, oil derivatives, boron, selenium and heavy metals in irrigation supplies or surface, drainage and ground waters should be considered.

Findings:

2.3 Organic pollution

Are nutrients, organic compounds and pathogens being reduced or introduced and concentrated, due to the Project, its dams and its associated domestic settlements? If so, does the change result in a reduction or increase in environmental and water use problems in the Project area or downstream (in rivers, canals, reservoirs, end lakes, evaporation wet lands, depressions, deltas, estuary regions) or in the groundwater?

Findings:

2.4 Anaerobic effects

Is the Project reducing or creating anaerobic conditions or eutrophication in any impoundments, natural lakes, pools or wetlands due to changed input or accumulation of fertilisers, other nutrients and organic matter or due to changed water quality resulting from dams, river abstractions and drainage flows?

Findings:

2.5 Gas Emissions

Is the Project, either directly or through associated industrial processing, causing decreased or increased gas emissions which contribute to air pollution (O_3, SO_3, H_2S, NO_x, NH_4, etc) or the greenhouse effect (CO_2, CH_4, NO_x, etc)?

Findings:

3. Soil properties and salinity effects

3.1 Soil salinity

Is the Project leading to progressive accumulation of salts in the soils of the project area or the vicinity because of prevailing high salt content in, the soil, the groundwater, or the surface water; or can a progressive leaching effect be expected?

Findings:

3.2 Soil properties

Is the Project leading to changes in soil characteristics within the Project area or the vicinity due to such activities as irrigation, the application of fertilisers or other chemicals, cultivation practices or dewatering through drainage? Changes which can improve or impair soil structure, workability, permeability, fertility associated with nutrient changes, humus content, pH, acid sulphate or hard pan formation or available water capacity should be considered.

Findings:

3.3 Saline groundwater

Are changes to the rates of seepage, percolation or leaching from the Project and its dams increasing or decreasing the concentrations of chlorides, nitrates or other salts in the groundwater?

Findings:

3.4 Saline drainage

Are changes to the concentrations of chlorides, nitrates or other salts in the runoff or drainage water from the Project area in danger of affecting biological communities or existing or potential downstream users (particularly during low flow conditions)?

Findings:

3.5 Saline intrusion

Are the Project and its dams leading to changes in saline water (sea water) intrusion into the estuary or into groundwater due to changes in low flow, groundwater use, dredging or river training? If so, are the changes likely to affect biological communities and water users in the Project vicinity and other areas?

Findings:

4. Erosion and sedimentation

4.1 Local erosion

Is increased or decreased soil loss or gully erosion being caused within or close to the Project area by changes in land gradient and vegetative cover, by irrigation and cultivation practice, from banks of canals, roads and dams, from areas of cut and fill or due to storm drainage provision?

Findings:

4.2 Hinterland effect

Are the Project and its dams leading to changes in natural vegetation, land productivity and erosion through changes in population density, animal husbandry, dryland farming practices, forest cover, soil conservation measures, infrastructure development and economic activities in the upper catchment and in the region surrounding the Project?

Findings:

4.3 River morphology

Is the regime of the river(s) changed by the Project and its dams through changes in the quantity or seasonal distribution of flows and flood peaks in the river(s), the abstraction of clear water, changes in sediment yield (caused by 4.1 and 4.2), the trapping of sediment in reservoirs or the flushing of sediment control structures? If so, do these changes benefit or impair aquatic ecosystems or existing or potential users downstream?

Findings:

4.4 Channel structures

Is scouring, aggradation or bank erosion in the river(s), endangering the Project's river headworks, offtake structures, weirs or pump inlets, its canal network, drainage or flood protection works, the free flow of its drainage system or structures and developments downstream? Consider effects associated with changes noted in 4.3 as well as those caused by other existing and planned upstream developments.

Findings:

4.5 Sedimentation

Are the changes noted in 4.1 - 4.4 causing increased or decreased sediment deposition in irrigation or drainage canals, hydraulic structures, storage reservoirs or on cultivated land, either via the irrigation system or the river(s)? If so, do these changes benefit or impair soil fertility, Project operation, land cultivation or the capacity and operation of reservoirs?

Findings:

4.6 Estuary erosion

Are the Project and its dams leading to changes in the hydrological or sediment regimes of the river which can affect delta formation or estuary and coastal erosion? If so, do these changes benefit or impair aquatic ecosystems (estuarine or marine), local habitation, navigation or other uses of the estuary?

Findings:

5. Biological and ecological changes

Is the Project, its dams or its associated infrastructure causing substantial and permanent changes (positive or negative) within the habitats listed in 5.1 - 5.5?

- in the natural ecology (habitat, vegetation, terrestrial animals, birds, fish and other aquatic animals and plants),
- in areas of special scientific interest, or
- in biological diversity

Include the likely ecological benefit of any new or modified habitats created and of any protective or mitigatory measures adopted (such as nature reserves and compensatory forests).

5.1 Project lands

The lands within the project area.

Findings:

5.2 Water bodies

Newly created, altered or natural channels, reservoirs, lakes and rivers.

Findings:

5.3 Surrounding area

All terrestrial areas influenced by the Project works and its associated domestic settlements and hinterland effects.

Findings:

5.4 Valleys and shores

River and canal banks, lake, reservoir and sea shores and the offshore marine environment.

Findings:

5.5 Wetlands and plains

Floodplains or permanent wetlands including deltas and coastal swamps.

Findings:

5.6 Rare species

Is the existence of any rare, endangered or protected species in the region enhanced or threatened by the changes noted in 5.1 - 5.5?

Findings:

5.7 Animal migration

Does the Project, its dams or new road/rail routes affect the migration patterns of wild animals, birds or fish? Make allowance for the compensatory effect of any additional provision within the Project (canal crossings, fish passes, spawning locations, resting or watering places, shade, considerate operation).

Findings:

5.8 Natural industry

Are commercial or subsistence activities depending on the natural terrestrial and aquatic environment benefited or adversely affected by the Project through ecological changes or changes in human access? Changes affecting such activities as fisheries, harvesting from natural vegetation, timber, game hunting or viewing and honey production should be considered.

Findings:

6. Socio-economic impacts

6.1 Population change

Is the Project causing significant demographic changes in the Project area or vicinity which may affect social harmony? Changes to population size/density and demographic/ethnic composition should be considered.

Findings:

6.2 Income and amenity

Is the Project introducing significant economic/political changes which can increase or decrease social harmony and individual well-being? Changes in the general levels of employment and income, in the provision of local infrastructure and amenities, in the relative distribution of income, property values and Project benefits (including access to irrigation water) and in the demand for labour and skills (particularly in relation to family/political hierarchy and different sexes and social groups) should be considered.

Findings:

6.3 Human migration

Has adequate provision been made for any temporary or migratory population influx to avoid social deprivation, hardship or conflicts within these groups or between the permanent and temporary groups? Human migration arising both from the demand for skills/labour during construction and from the requirements for seasonal agricultural labour should be considered.

Findings:

6.4 Resettlement

Has adequate provision been made for the resettlement, livelihood and integration of any people displaced by the Project and its dams or losing land, grazing or other means of income due to the Project? Also, has adequate provision been made for the subsistence farming needs of people settled on or associated with the Project?

Findings:

6.5 Women's role

Does the Project change the status and role of women (positively or negatively) in relation to social standing, work load, access to income and heritage and marital rights?

Findings:

6.6 Minority groups

Are the Project and its dams causing changes to the lifestyle, livelihoods or habitation of any social groups (particularly minority groups) leading to major conflicts with, or changes to their traditional behaviour, social organisation or cultural and religious practices?

Findings:

6.7 Sites of value

Is access improved or hampered to places of aesthetic and scenic beauty, sites of historical and religious significance or mineral and palaeontological resources? Also, are any such sites being destroyed by the Project?

Findings:

6.8 Regional effects

Are the economic, infrastructural, social and demographic changes associated with the Project likely to enhance, restrict or lead to unbalanced regional development? Also, has adequate provision been made for new transport, marketing and processing needs associated with the Project?

Findings:

6.9 User involvement

Has there been adequate user and public participation in project planning, implementation and operation to ensure Project success and reduce future conflicts? The potential for incorporating within the Project existing systems of land tenure, traditional irrigation, and existing organisational and sociological structures and for the provision of new or extended facilities for credit, marketing, agricultural extension and training should be considered.

Findings:

6.10 Recreation

Are the Project and its dams creating new recreational possibilities (fishing, hunting, sailing, canoeing, swimming, scenic walks, etc) and are existing facilities impaired, preserved or improved?

Findings:

7. Human health

Consider each of the items 7.1 - 7.9 in relation to the local population, the labour force during construction and their camp followers, the resettled and newly settled populations and migratory labour groups.

7.1 Water and Sanitation

Are the provisions for domestic water, sanitation and refuse disposal such that oral, faecal, water washed and other diseases and the pollution of domestic water can be controlled?

Findings:

7.2 Habitation

Are the provisions for housing and forecast population densities such that diseases related to habitation or location of dwellings can be controlled?

Findings:

7.3 Health services

Are general health provisions adequate (treatment, vaccination, health education, family planning and other health facilities)?

Findings:

7.4 Nutrition

Is the Project leading to an increase or decrease in the general nutritional status of the population or to changes in other lifestyle or income related diseases? If so, are any specific groups particularly exposed to such health risks?

Findings:

7.5 Relocation effect

Are population movements introducing new infectious or water-related diseases to the Project area or causing stress-related health problems or bringing people with a low resistance to particular diseases into areas of high transmission?

Findings:

7.6 Disease ecology

Are the extent and seasonal character of reservoirs, canals, drains, fast flowing waters, paddy fields, flooded areas or swamps and the closeness or contact of the population with such water bodies leading to significant changes in the transmission of water related diseases?

Findings:

7.7 Disease hosts

Are the populations of intermediate and other primary hosts of parasitic and water-related diseases (rodents, birds, monkeys, fish, domestic animals) and the interaction of the human population with these hosts, decreased or increased by the Project?

Findings:

7.8 Disease control

Can the transmission of the diseases identified in 7.1, 7.2, 7.5, 7.6 and 7.7 be reduced by introducing into the Project environmental modifications or manipulations or by any other sustainable control methods? Possible environmental measures include both removal of breeding, resting and hiding places of vectors and reducing contamination by and contact with humans.

Findings:

7.9 Other hazards

Is the risk to the population decreased or increased with respect to:

- pathogens or toxic chemicals present in irrigation water (particularly through wastewater reuse) or in the soils, which can accumulate in food crops or directly threaten the health of the population;
- dwellings adequately located and designed to withstand any storm, earthquake or flood hazards;
- sudden surges in river flow caused by the operation of spillways or power turbines; and
- structures and water bodies designed to minimise accident and allow escape?

Findings:

8. Ecological imbalances

8.1 Pests and weeds

Are crop pests or weeds likely to increase or decrease (particularly those favoured by irrigation/drainage/flood control) affecting yields, cultivation and requirements for pesticides or herbicides?

Findings:

8.2 Animal diseases

Are domestic animals in the Project or vicinity more or less exposed to hazards, diseases and parasites as a result of the Project and its dams?

Findings:

8.3 Aquatic weeds

Are reservoirs, rivers or irrigation and drainage canals likely to support aquatic vegetation or algae? If so, can these plants be harvested or controlled, or will they reduce the storage/conveyance capacity, interfere with the operation of hydraulic structures or lead to oxygen-oversaturated or anaerobic water bodies?
Findings:

8.4 Structural damage

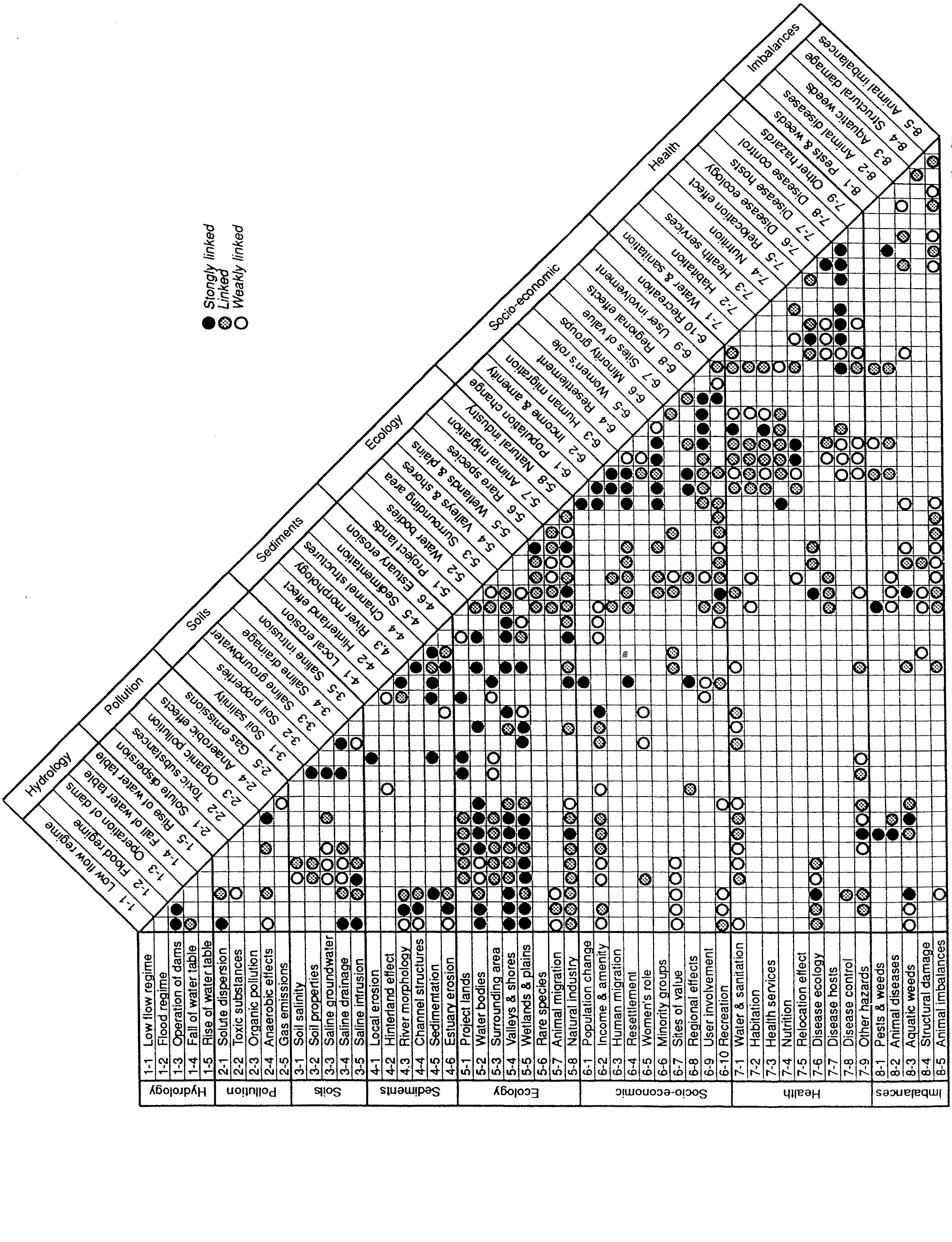
Is there a danger of significant damage being caused to dams, embankments, canal banks or other components of the irrigation/drainage/flood control works through the action of plants and animals (including rodents and termites) favoured by the Project?
Findings:

8.5 Animal imbalances

Does the Project cause zoological imbalances (insects, rodents, birds and other wild animals) through habitat modification, additional food supply and shelter, extermination of predators, reduced competition or increased diseases?
Findings:

Additional findings and comments

Table A1.1 Links between environmental effects



Appendix 2

REFERENCES RELATED TO CHECK-LIST ITEMS

REFERENCES RELATED TO CHECK-LIST ITEMS

The following selected list of references has been prepared to assist users to identify specific publications which explain the significance of each item in the Check-list and the methods available for monitoring or predicting changes associated with each item. Items listed in the references are believed to be widely available.

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Appendix 3

COVER SHEET AND GENERAL DATA SHEETS FOR BASIC INFORMATION AND PROJECT CHARACTERISTICS

COVER SHEET

Report of assessment of environmental effects using the ICID check-list

Name of Project Phase (if relevant)

Location (country, region, district):

Nearest town(s): Name Distance from Project (km)

Summary of The Project (the new or existing development or phase of development on which the Check-list is being used)

(a) Type (Irrigation/Drainage/Flood protection/Reclamation/.....:.)

(b) Status (Evaluation of existing/Expansion of existing/Rehabilitation of existing/Modernisation of existing/New/.....)

(c) Dates (actual/planned) Start:
Completion:

Reports and previous studies relating to the project (date, title, bibliographic details)

Official responsible for the assessment:

Name Profession

Organisation

Position

Who has overall responsibility for the Project for:

Planning

Implementation

Management

Assessment Progress Record:

Date	Description of work begun/completed

GENERAL DATA SHEETS
FOR BASIC INFORMATION AND PROJECT CHARACTERISTICS

D 1 General information and nearby projects

D1.1 Describe briefly the main characteristics of the Project in sufficient detail to introduce the Project's purpose, physical characteristics and regional and economic importance.

D 1.2 If the Project is existing, describe the history of the scheme, in relation to its original purpose and if rehabilitation is now required, give the reasons.

D 1.3 Give details of existing or planned projects of similar type near to the Project

Name & Phase	Cultivated area (ha)	Distance from Project (km)	Source of irrigation/ drainage/ flood water	Construction Dates (actual or planned)	
				start	complete

Reports on environmental effects of these projects (date, title, bibliographic details).

D 1.4 Describe known risks of serious natural hazards in the region (earthquake, volcanoes, landslides, mudflows, devastating storms, seawater ingression, locust invasions, frequent drought, others)

D 1.5 Land area and population of the Project and any other planned phases of development in the same project area.

	Completion Date	Project Area (ha)						Population
		Irrigated	Drained	Reclaimed	Flood protected	Other land	Total	
Phase 1								
Phase 2								
Phase 3								

D 1.6 Give the proportion of farmers or farm workers living:

	Phase 1	Phase 2	Phase 3
(a) in existing villages			
(b) in new permanent villages			
(c) in temporary villages			
(d) in scattered houses			

D 1.7 Name existing villages in the region of the project and say whether villagers work/will work on the Project.

	Name	Work on Project		Name	Work on project
A.		Yes/No	D.		Yes/No
B.		Yes/No	E.		Yes/No
C.		Yes/No	F.		Yes/No

D 1.8 Attach a sketch map of the Project, (or detailed topographic map, if available) showing water source, reservoirs, main roads, levees, canals and drains, areas irrigated, drained or reclaimed, Project boundary, Project headquarters and workshops, approximate scale, elevations and north direction, existing villages (marked A, B,...), sites of planned new villages (marked V1, V2, ...) and sites where soil and water samples have been obtained (eg S1, W1, G1 ... see questions S3.12 and S4.10). For villages off the map show an arrow with the distance. Indicate where further phases of development are planned if relevant.

D 1.9 Additional general information and list of reports/references consulted (in addition to those listed in D 1.3)

D 2 Surface water resources

(* indicates 'delete as appropriate')

Complete D 2.1 to D 2.9 for each river supplying or liable to flood the Project.

D 2.1 Name of river

D 2.2 Catchment area at (closest point to the Project)*
or (point of abstraction)* ..... km^2

D 2.3

	1	2	3
Gauging stations	Name	.....	.....
Catchment area at gauging station	(km^2)	.....	.....
Gauge zero	(m a MSL)	.....	.....
Observation period	from	.....	.....
	to	.....	.....

D 2.4 Discharges and water quality (estimated at Project)* or (measured at most informative gauging station .....)* in (m^3s^{-1})* or (other .....)*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean monthly@ a)													
b)													
Mean max@ a)													
b)													
Mean min@ a)													
b)													
Project abstraction return flow													
Any recorded conduct'y (mmho) pH													

@ If the Project requires a new reservoir or modified operation of an existing reservoir give discharges (a) without the Project and (b) with the Project.

D 2.5 Highest recorded flood peaks at the gauging station(s)

(a) Nearest to project

Name . . . . . Period . . . . . To . . . . . .

Catchment . . . . . km^2

(b) Longest record (if different from (a))

Name . . . . . Period . . . . . To . . . . . .

Catchment . . . . . km^2

	(a)			(b)	
No	m^3s^{-1}	date	No	m^3s^{-1}	date
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		

D 2.6 To what extent does water at the point of abstraction for, or closest point to, the Project contain untreated or partially treated sewage effluent?

D 2.7 Describe any significant uses of the river downstream of the Project for municipal-industrial water, irrigation, livestock, hydropower, fishing, aquaculture, recreation, navigation (including ferries) or gravel/sand extraction.

D 2.8 Give information about the extent and seasonal variations of saline intrusion at the mouth of the river and any abstractions which may be affected by increased saline intrusion.

D 2.9 Does the Project's own catchment area or that of any river considered in D 2 drain into terminal lakes and what are the effects of the Project on water level, surface area, shore lines, salt concentration, etc. of the lakes?

D 2.10 Additional water resources information and list of reports/references consulted.

D 3 **Groundwater**

(attach geological or hydrogeological map, if available)

D 3.1 Geological formations in which groundwater aquifer is found

D 3.2 Recharge area of groundwater system . . . . . km^2

Describe its dominant land use and foreseeable changes

D 3.3 Estimated natural rate of recharge . . . . . $mm\ yr^{-1}$

D 3.4 Existing uses of the groundwater system apart from the Project

	Uses	Number	Method of abstraction
Well < 3m deep			
Wells/boreholes > 3m			

D 3.5 Abstractions from the groundwater system for Project and other existing uses (m^3 $month^{-1}$)

Project	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Phase 1													
Phase 2													
Phase 3													
Other uses													

D3.6 Describe any important springs, surface waters or wetlands fed by the groundwater system.

D 3.7 Estimate the leaching fraction if irrigation water is used ..... %

D 3.8 Provide isobath maps if available or give the range of depths to the water table within the Project when it is at its highest level?

D 3.9 What area of the Project has a water table depth of less than 2m when it is at its highest level? . . . . . ha

D 3.10 What is the typical annual fluctuation in water table depth in the Project area? . . . . . m

D 3.11 Additional groundwater information and list of reports/references consulted.

D 4 **Soils**

(attach soil map, if available)

D 4.1 Describe the main soil types found in the Project area

Type/ texture	Depth (m)	Field (water holding) capacity (%)	Proportion of Project covered (%)

D 4.2 Describe significant subsoil/geological formations in the Project area

D 4.3 Surface slope in the Project area

Slope (%)	0 - 1	1 - 3	3 - 5	5 - 10	> 10
Proportion of area (%)					

D 4.4 Additional soils information and list of reports/references consulted.

D 5 **Meteorological data**

D 5.1 Available records (R = rainfall, T = temperature, WS = wind speed, WD = wind direction, RH = relative humidity, E = evaporation pan)

	A	B	C
Name of station(s)	.....	.....	.....
Location (km from project)	.....	.....	.....
Elevation (m a MSL)	.....	.....	.....
Observation period (from/to)	.....	.....	.....
Record types (see above)	.....	.....	.....

D 5.2 Mean monthly rainfall in mm at Station ..... or interpolated for Project area

Jan	Apr	Jul	Oct
Feb	May	Aug	Nov
Mar	Jun	Sep	Dec
		Annual Total	

D 5.3 Highest known daily rainfall totals (in mm) in rank order for stations A, B and C

	A	B	C		A	B	C
1.				6.			
2.				7.			
3.				8.			
4.				9.			
5.				10.			

D 5.4 Mean monthly evaporation in mm

(Station ....., length of records ..... and method.....)

Jan	Apr	Jul	Oct
Feb	May	Aug	Nov
Mar	Jun	Sep	Dec
		Annual Total	

D 5.5 Mean monthly temperatures in °C at Station .....

	Mean Daily Max	Mean Daily Min	Mean		Mean Daily Max	Mean Daily Min	Mean
Jan				Jul			
Feb				Aug			
Mar				Sep			
Apr				Oct			
May				Nov			
Jun				Dec			
				Year			

Indicate (F) the months where frost may occur.

D5.6 Mean monthly relative humidity in (%) at Station .....

Method used..... Time of day..... Period.....(years)

Jan	Apr	Jul	Oct
Feb	May	Aug	Nov
Mar	Jun	Sep	Dec

D 5.7 Monthly distribution of wind velocity and direction at Station .....

	Mean Velocity ($m\ s^{-1}$)	% in Major Direction(s) (eg NE ....%)		Mean Velocity ($m\ s^{-1}$)	% in Major Direction(s)
Jan			Jul		
Feb			Aug		
Mar			Sep		
Apr			Oct		
May			Nov		
Jun			Dec		

D 5.8 Describe the wind and climate systems (NE monsoon during Nov to Feb, etc)

D 5.9 Additional meteorological information and list of reports/references consulted.

D 6 **Irrigation system**

(If Project includes no irrigation go to D 7)

D 6.1 What is the source of supply and method of delivery (you may tick more than one)

	Gravity	Pumping	Canal	Pipeline
River (with weir)				
River (without weir)				
Existing reservoir				
New reservoir				
Natural lake				
Existing canal				
Dug well				
Borehole				
Sand bed abstraction				
Spring				
Water harvesting				
Other				

D 6.2 What is the rate of water supply at maximum demand? . . . . . ls^{-1}

D 6.3 In calculating the irrigation demand, what are the approximate allowances made for crop needs, losses etc as a proportion of the total water supplied from either surface or groundwater?

	Surface water sources	Groundwater sources
Crop needs (%)		
Surface drainage (%)		
Sub-surface drainage (%)		
Deep percolation (%)		
Direct evaporation (%)		
Conveyance losses (%)		

D 6.4 What proportion of the irrigation demand will be met by

(a) reusing drainage water within the Project %

(b) reusing drainage water from other projects %

(c) using treated sewage effluent %

(d) using untreated sewage effluent %

D 6.5 Are there subsidiary (buffer) storage reservoirs within the Project boundary?

Number: Approximate sizes: m^3

D 6.6 Details of surface distribution network.

	Approximate canal length (km)		Types of lining	Types of crossing (bridge/culvert/ ford/ . . . . .)
	lined	unlined		
(a) Main				
(b) Secondary				
(c) Tertiary				
(d) Field				

D 6.7 Method of irrigation:

surface/overhead/micro-irrigation (drip etc)

D 6.8 If "surface" state method:

flood/furrow/border strip/ .....

D 6.9 and state how the discharge to the fields is controlled?

siphon/outlet structure/breeched bank/ .....

D 6.10 For how many hours during the day is irrigation normally practised?
daytime .....hours, night-time .....hours

D 6.11 Are fields irrigated continuously/by rotation?

D 6.12 If "rotation" give typical interval(s) . . . . . days

D 6.13 And do the following fall dry between irrigation intervals?

fields	yes/no	main canals	yes/no
field canals	yes/no	drainage canals	yes/no
secondary canals	yes/no	buffer reservoirs	yes/no

D 6.14 What is the typical length of time during which no irrigation takes place (between the principal crops or seasons) and when do these occur?

	Typical period without irrigation (weeks)	Time of year (months)
(a)		
(b)		
(c)		

D 6.15 Would it be possible to drain the irrigation system dry during these periods?

Refer D 6.14	Canals	Buffer reservoirs	Drains
(a)	yes/no	yes/no	yes/no
(b)	yes/no	yes/no	yes/no
(c)	yes/no	yes/no	yes/no

D 6.16 Who will have the following responsibilities (if not applicable, write NA)?

	Operation	Maintenance
Water source		
Main supply system		
Secondary canals		
Field canals		
Drainage works		
Roads, fences etc	NA	

D 6.17 Additional information on the irrigation system and list of reports/references consulted.

D 7 **Drainage and flood control systems and other works.**

D 7.1 Details of the Project's drainage system: Area drained . . . . . ha
Main purpose (water table control, flood-plain drainage, storm run-off, irrigation surplus, leaching, ...)

Discharging into (river, lake, swamp, depression, ...)

	Uppermost drains	Collector drains	Main drains	Catch drains
Surface - unlined (km) - lined (km) (Material)				
Subsurface (km) (Type/Material)				
Long section gradients				
Bank slopes				
Drainage water pumped	Yes/no	Yes/no	Yes/no	Yes/no
Volume of buffer storage (m^3)				

D 7.2 Describe other provisions of the drainage system

- crossings: (bridges, culverts, fords, cattle crossings)

- drainage canals having a combined storm/dry weather profile

- drain flushing facilities

- routine maintenance: (hand labour/mechanical, frequency, etc)

D 7.3 Project works to control floods and the sources of flooding

- river training: length .....(km) describe
- river dredging: length .....(km) describe
- river embankment: length .....(km) describe
- coastal dike: length .....(km) describe
- cut-off drains: length .....(km) describe
- land fill: volume .....(m^3) describe

D 7.4 Provisions in flood protected area

Area protected .....ha

Characteristics (main drain(s)/sluices/pumping/buffer storage)

D 7.5 Does the Project create any borrow pits for earth structures?

- mark their locations on the map in D 1.8 using symbols P_1, P_2 etc
- are pits drained/undrained?
- do they form temporary/permanent water bodies?

D 7.6 Describe any provisions in the Project for the benefit of wildlife?

- canal crossings, fish ladders, places for hiding, resting, spawning, nesting
- operational measures for habitat enhancement

D 7.7 Additional information on drainage and flood control systems and list of reports/references consulted.

D 8 **Cultivation and Crops**

Give details of the principal crops or groups of crops to be grown within the Project including forestry or other plantations.

	Crop 1	Crop 2	Crop 3	Crop 4
D 8.1 Name of crop				
D 8.2 Planting date(s)				
(a) 1st planting				
(b) 2nd planting				
(c) 3rd planting				
D 8.3 Approximate areas (ha)				
(a)				
(b)				
(c)				

D 8.4 Irrigation requirement (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
Crop 1													
Crop 2													
Crop 3													
Crop 4													

D 8.5 Is the raising of livestock a planned activity within the Project area?

Type	Area used (ha)	Stocking density	Way of feeding

D 8.6 If aquaculture occurs within the Project give details:

D 8.7 Additional information on cultivation and crops and list of reports/references consulted.

D 9 **Domestic water supplies and sanitation**

Where do most farmers and their families and other people associated with the Project obtain water for the stated activities (Types (a) open well; (b) protected well; (c) borehole; (d) individual tap; (e) shared tap; (f) canal; (g) drain; (h) pool; (i) reservoir; (j) roof collection; (k) other .....)

	Existing facilities			New facilities		
	Type(s)	People served (%)	Average distance (km)	Type(s)	People served (%)	Average Distance (km)
D 9.1 Drinking water?						
D 9.2 Personal washing?						
D 9.3 Clothes washing?						

D 9.4 On completion of any new facilities, how will drinking water be treated?
/centrally/individually/not at all/

D 9.5 If "centrally", who will be responsible for operation and maintenance of the treatment works?

D 9.6 And what treatment methods will be used?

D 9.7 What types of domestic sanitation (sewage disposal) are available in the villages?

Existing:

New:

D 9.8 On completion of any new facilities, will households have individual latrines or will they share facilities?

Individual .....(%); Shared .....(%); None .....(%)

D 9.9 And who will be responsible for their maintenance?

D 9.10 What type of sanitation, if any, will be available in the fields?

D 9.11 What type(s) of rain water disposal or drainage system is available to the villages in the Project?

D 9.12 What provisions are there for solid waste disposal?

D 9.13 Additional information on domestic water supplies and sanitation and list of reports/references consulted.

Appendix 4

SPECIALISED DATA SHEETS RELATING TO PARTICULAR IMPACTS

SPECIALISED DATA SHEETS RELATING TO PARTICULAR IMPACTS

S 1 Dams and Reservoirs

These questions are restricted to environmental aspects of relevance for adjoining irrigation, drainage or flood control projects. A comprehensive environmental impact assessment of large dams and reservoirs may be done by following the guidelines of ICOLD.

Complete data sheet S1 for each reservoir which is part of the Project or whose operation may change or may be affected because of the Project.

S 1.1

	Name of reservoir	River	Type of dam	Length (km)	Year completed/planned
R_1					
R_2					
R_3					

			R_1	R_2	R_3
S 1.2	Catchment area	km^2			
	Land use:				
	- forest	%			
	- grassland	%			
	- paddy fields	%			
	- other cropland	%			
	- plantation	%			
	- bare/eroded lands	%			
	- rock outcrops	%			
	- others	%			

			R_1	R_2	R_3
S 1.3	<u>Inflow/Outflow data</u>				
	Inflow - mean	10^6 m^3yr^{-1}			
	- wet year 1 in 5	"			
	- dry year 1 in 5	"			
	max. recorded flood	m^3 s^{-1}			
	spillway capacity	"			
	type of spillway	describe			
	min. compensation flow	m^3 s^{-1}			
	bottom outlet max flow	"			
	elevation	m aMSL			
	operation intakes max flow	m^3 s^{-1}			
	elevation(s)	m aMSL			
S 1.4	<u>Sedimentation:</u>				
	sediment inflow	10^3 t yr^{-1}			
	sediment trapping efficiency	%			
	floating debris inflow	10^3 t yr^{-1}			
	sedimentation/gross storage	% yr^{-1}			
	potential for sediment flushing	yes/no			
S 1.5	<u>Reservoir data:</u>				
	gross storage	10^6m^3			
	useful storage	"			
	flood control storage	"			
	dead storage	"			
	max. depth	m			
	max. water level	m aMSL			
	min. water level	"			
	surface area at: max WL	ha			
	min WL	"			
	mean depth at: max WL	m			
	min WL	"			
	shore length at: max WL	km			
	min WL	"			

			R_1	R_2	R_3
S 1.6	Reservoir uses: hydro power (installed) flood control water supply: - domestic - industrial - irrigation - flow augmentation reservoir navigation reservoir fisheries recreation hunting Other	 kW yes/no $10^6 m^3 yr^{-1}$ " " " yes/no $t\ yr^{-1}$ yes/no yes/no			
S 1.7	Submerged areas: displaced people loss cultivable land other losses (infrastructure, sites of value, etc) describe: clearing of forests potential agriculture in drawdown zone	 number ha yes/no ha			
S 1.8	Water body: eutrophication/reference date oligo- < meso- < eutroph - phosphorus concentration 10 < 30 < 80 - secchi visibility 10 > 4 > 2.5 - assimilative productivity 200 < 600 < 1000 mass development of aquatic weeds anaerobic hypolimnion anaerobic outflow low temperature outflow	 $mg\ m^{-3}$ m $mgCm^{-2}d^{-1}$ species period of yr period of yr period of yr			

S 1.9 Additional information on dams and reservoirs and list of reports/references consulted.

S 2 **Flooding and Wetlands**

S 2.1 In the land occupied by or adjacent to the Project, what is the approximate area of previously existing floodplains . . . . . ha or wetlands? . . . . ha

S 2.2 Describe the floodplain/wetland types and their significance (special features, current uses, breeding grounds, size relative to similar wetlands in the vicinity, etc.)

S 2.3 What area of these floodplains or wetlands have been or will be drained or protected from flood inundations as part of any planned changes associated with the Project? Floodplains ..... ha ; Wetlands .....ha

S 2.4 Describe the extent to which any Project works increase the maximum likely flood levels upstream or downstream?

S 2.5 What new areas of wetlands are created by the Project?

Paddy fields	.....ha	Drainage system	..... ha
Waterlogging	.....ha	Depressions or sumps where drainage water collects	..... ha

S 2.6 Downstream of the Project, what is the total area of floodplain which is regularly inundated by floods? . . . . . ha

S 2.7 How many times during the year does inundation generally occur?

S 2.8 What is the total duration of such inundations in a typical year?

. . . . . days

S 2.9 In what ways do any planned changes within the Project modify these inundations?

S 2.10 Additional information on flooding and wetlands and list of reports/references consulted.

S 3 **Organic and inorganic pollution**

For the entire drainage basin in which the Project is to be located, give details of all abstractions of surface water and return flows. If necessary complete S 3.1 to S 3.11 separately for more than one basin.

Name(s) of river(s)

S 3.1 Total drainage basin area . . . . . km²

S 3.2 Drainage basin area upstream of Project . . . . . km²

S 3.3 Mean annual runoff of drainage basin . . . . . mm

S 3.4 Describe the condition of the drainage basin (population/major towns/ agriculture/types of industry):
Upstream:

Downstream:

S 3.5 Estimate present water use without the Project (reference year .....)

	Abstraction (m^3yr^{-1})		Return flows (% of abstractions)	
	Upstream	Downstream	Upstream	Downstream
(a) Domestic and municipal use				
(b) Agriculture				
(c) Industry				
(d) Mining				
(e) Cooling water (power)				
(f)				
TOTAL				

S 3.6 Projected water use (including the Project) for the year .....

	Abstraction (m^3yr^{-1})		Return flows (% of abstractions)	
	Upstream	Downstream	Upstream	Downstream
(a) Domestic and municipal use				
(b) Agriculture				
(c) Industry				
(d) Mining				
(e) Cooling water (power)				
(f)				
TOTAL				

S 3.7 In what ways are long-term plans for the agricultural, industrial and urban development of the basin likely to affect this pattern of abstractions and return flows?

S 3.8 Who is responsible for authorising abstractions from the drainage basin?

S 3.9 Who is responsible for administering water quality regulations in the drainage basin?

S 3.10 Give the approximate proportion of the area of the drainage basin to which agro-chemicals are regularly applied

	fertilizers	others
(a) pre-Project	%	%
(b) after any planned changes in the Project	%	%

S 3.11 Are crop residues likely to get into the drainage water?

From the Project ..... Elsewhere .....

S 3.12 Obtain a detailed chemical analysis of a sample of water obtained from each of the surface water sources or drains (mark sampling points on the map in D 1.8, as W_1, W_2, etc) and representative groundwater sampling points (marked on the map as G_1, G_2, etc)

Sample Number Date			W_1					G_1				
River or ground water level (1)												
Conductivity (mmho) pH Hardness												
Cations	Ca	(mg l^{-1})										
	Mg	(mg l^{-1})										
	Na	(mg l^{-1})										
	K	(mg l^{-1})										
	Li	(mg l^{-1})										
	Fe	(mg l^{-1})										
Anions	CO_3	(mg l^{-1})										
	HCO_3	(mg l^{-1})										
	Cl	(mg l^{-1})										
	SO_4	(mg l^{-1})										
	NO_3	(mg l^{-1})										
	NH_4	(mg l^{-1})										
	PO_4	(mg l^{-1})										
Toxics	B	(mg l^{-1})										
	Se	(mg l^{-1})										
heavy metals		(mg l^{-1})										
		(mg l^{-1})										
Temperature		(°C)										
O_2		(mg l^{-1})										
BOD		(mg l^{-1})										
COD		(mg l^{-1})										

(1) Was the discharge or water level high(h) medium(m) or low(l) at the time of sampling? - give data if available.

S 3.13 Describe any significant findings from biological analyses (benthic flora/fauna, pathogens etc.) of the above samples

Sample number	Details

S 3.14 Give details of untreated, partially treated or treated sewage from the population on the Project likely to reach the drainage water.

S 3.15 Is effluent from domestic animals or from silage production associated with the Project likely to reach the drainage water?

S 3.16 Give details of any industrial processing units associated with the Project or its population which exist or may be built in the region. What are their water requirements and source, what are the quality and quantity of their return flows and what atmospheric pollutants are released?

S 3.17 Additional information on pollution and list of reports/references consulted.

S 4 **Soil properties and salinity effects**

S 4.1 Give areas of land within the Project with salt crusts on the soil and areas with salt tolerant plants

Salinised land .....ha Salt tolerant plants .....ha

S 4.2 From a study of existing irrigated cultivation within the Project or nearby, describe any long-term changes which may be related to sodicity (declining infiltration rates, crust formation on drying, blacker colour, harder clods)

S 4.3 Do you find salt crust strips along the banks of rivers and drains at the limit of capillary rise or on the walls of open wells at the limit of capillary rise and, if so, what is their depth below ground surface?

..... m

S 4.4 Estimate the areas within the Project of waterlogged depressions or of plants which require a high moisture level or tolerate a high water table

Waterlogged .....ha Moisture tolerant plants .....ha

S 4.5 Does the soil profile anywhere within the Project show gleying due to permanent anaerobism, or mottling due to a high but fluctuating water table or is there a foul sulphurous smell on digging?

S 4.6 Estimate, if possible, the direction of flow of the groundwater (from the natural drainage network and topography or a survey of wells) and estimate the mean horizontal soil permeability (bore hole method)

S 4.7 Does ochre appear in the ditches and pipes of existing drainage systems or has a rapid and severe drop in soil pH been observed after draining soils similar to those in the Project area?

S 4.8 Describe any existing projects in the region of similar characteristics which show signs of suffering decreased production due to excess salt, excess water or other soil related causes?

S 4.9 Are there existing hard pan or lateritic layers in the Project?

Area .....ha Range of depth below surface ..... m

S 4.10 Give the results of any soil analysis for soluble and exchangeable ions (Adjusted Sodium Absorption Ratio), organic compounds and toxic chemicals (eg Boron) in the soils to be irrigated

Ion/Compound	Method of analysis	Units	Amount in samples from (mark locations on map, D1.8)			
			S_1	S_2	S_3	S_4

Attach copies of more detailed soil analyses and mark their positions on the map (D 1.8)

S 4.11 Additional information on soil properties and salinisation effects and list of reports/references consulted.

S 5 Erosion and siltation

It may be necessary to complete questions S5.1 - S5.7 separately for each river supplying or liable to flood the Project.

Name of river (see D 2.1) . . . . . .

S 5.1 Is the river upstream and downstream braiding / meandering / depth eroding / bank eroding / sediment accumulating / channelized / trained / bank protected / other?

S 5.2 Give details of representative suspended sediment concentrations in the river during high flows for gauging stations listed in D 2.3

Station	Observation date	gauge reading (m) or discharge (m^3s^{-1})	Suspended concentration (mg l^{-1})	Methods used for measurement and calculation

S 5.3 What is the size of the stream bed material at the location of the off-take or closest point of contact with the Project silt/fine sand/course sand/gravel/ boulders?

Describe its petrographic composition especially the proportion of quartz particles. Attach the bed material size distribution from a sieve analysis if available.

S 5.4 What is the mean gradient of the river over a distance of 2km upstream of the water off-take or along the flood protection works?

S 5.5 Is the off-take located at a straight river stretch/at the outer bank/inner bank of a river bend?
What measures are included in its design to exclude or trap sediment?

S 5.6 What is the difference between the upstream and downstream water levels at any weir/barrage(s) during medium to low flows ..... m
Give details of any discharge gates below the sill level of the off-take which could act as sediment sluices?

S 5.7 Is the stream bank stable at the location of the canal off-take, pump intake, drainage outfall, embankment or other Project works, or is there evidence of previous changes to the position of the channel?

Describe any bank protection works included in the Project.

S 5.8 Do any natural streams, drains or gullies discharge flood water into buffer reservoirs or the irrigation canals or are they adequately protected by cut-off drains and culverts?

S 5.9 What arrangements exist to excavate sediments from canals and drains and where is it deposited?

S 5.10 Provide any available information on soil erosion rates in this or neighbouring drainage basins and describe soil conservation activities.

S 5.11 Describe measures, if any, to control the livestock on the Project or outside the Project boundaries to prevent erosion?

S 5.12 For what proportion of the households associated with the Project is fuelwood a major source of fuel?

S 5.13 If wood is used, what provision has been made for fuelwood plantations?

S 5.14 What proportion of the population associated with the Project practise dry-land cultivation in the surrounding area:

cultivating existing fields ..... %

requiring new areas to cultivate following implementation of the Project (.....ha) ..... %

S 5.15 Additional erosion and siltation information and list of reports/references consulted.

S 6 **Biological and ecological changes**

S 6.1 Changes in land use in the Project vicinity

	Without Project (ha)	With Project (ha)
Buildings and infrastructure		
Irrigated farming		
Dryland farming		
Permanent grazing		
Seasonal grazing*		
Ungrazed scrubland*		
Forest* (types . . . . .) (. . . . .)		
Permanent/seasonal wetlands* (See S 2.1 to S 2.6)		
Others (. . . . .)		
Total		

(*indicate double counting)

S 6.2 Area cleared of natural vegetation as a result of the Project . . . . . ha

Area planted with compensatory forest . . . . . ha

Describe significant positive and negative changes to natural flora and fauna resulting from the Project. Underline rare and/or endangered species (___) and biologically and environmentally important species (_ _ _ _ _). For migratory species see S 6.10.

S 6.3

	Species	Location(s)	Effect
Natural Vegetation			

		Species	Location(s)	Effect
S 6.4	Wild Animals			
S 6.5	Birds & Water fowl			
S 6.6	Fish			
S 6.7	Other species			

S 6.8 How does the Project increase, reduce or affect

- parks, natural reserves, national forests?

- wildlife refuges?

- scientifically valuable areas?

- other ecological reserves?

S 6.9 How does the Project alter the long term productivity of the land?

S 6.10 How are migratory or roaming animals, birds or fish are affected by the Project with regard to their freedom of movement, access to water and food, availability of shelter and spawning, nesting or resting sites, or protection from predatory or competitor species (especially domestic animals)? See also D 7.6.

S 6.11 Additional information on biological and ecological changes and list of reports/references consulted.

S 7 **Socio-economic impacts**

S 7.1 Population in the vicinity of the Project (number)

	Without Project	With Project
- irrigation cultivators		
- dryland cultivators		
- livestock farmers		
- livestock nomads		
- shifting cultivators		
- hunters		
- fishermen		
- others		

S 7.2 The farmers benefitted by the Project consist of former

	number
- irrigation farmers	
- dryland farmers	
- livestock farmers	
- livestock nomads	
- shifting cultivators	
- hunters	
- fishermen	
- others	

S 7.3 The farmers benefitted by the Project are recruited from

	number
- local population remaining in their villages	
- local population resettled in new villages	
- population of same language and culture from other areas resettled in new villages	
- population of different sociological background resettled (describe)	

S 7.4 Does the farming within the Project depend on:

number

- family labour
- local labour
- seasonal labour, local
- seasonal labour, from other areas

S 7.5 Number of unemployed or underemployed within reach of the Project

S 7.6 Can Project works be carried out

number

- by local self-help labour
- by local contractors with local labour
- by contractor from another area with
  - local labour
  - labour from other areas
- by foreign contractors
  - expatriates
  - local labour
  - labour from other areas

S 7.7 Number of people, other than the Project population, losing traditional means of subsistence as a result of the Project (describe)

S 7.8 Describe provisions being made for these (S 7.7) to assure subsistence during and after Project construction

S 7.9 Number of new jobs created by the Project

	Number	Estimated annual income per job
- management and administration		
- skilled, for operation and maintenance		
- irrigation farming		
- dryland and pastoral farming		
- seasonal jobs, unskilled		
- fishery		
- secondary jobs in processing and marketing of Project products		

S 7.10 Estimated immigration of people due to Project . . . . . number

S 7.11 Describe the pre-Project land tenure system

S 7.12 Land tenure system established or envisaged within the Project
(Existing dispersed land holdings or entitlements preserved/Distribution of land holdings to new farmers/large individual or corporate land holdings/ Government holding land)

S 7.13 Give the proportion of those cultivating Project land who

(a) farm land they own %
(b) farm as tenants of an individual or organisation %
(c) farm as tenants on Government land %
(d) are employed as workers or labourers %

S 7.14 Women's participation in farming; describe their role and changes in their sociological standing in family and society due to the Project

S 7.15 What are the provisions for subsistence farming for the Project population

(a) within the Project area

(b) outside the Project boundary

S 7.16 How does the Project directly affect or affect access to

- existing recreational facilities?

- new recreational opportunities?

- cultural / historical sites?

- religious sites?

- mineral resources?

- palaeontological resources?

- scenic beauty?

- other valuable sites?

S 7.17 Describe changes in infrastructure because of the Project

- railways
- roads
- electricity supply
- marketing facilities
- processing plants
- schooling
- training
- medical facilities

S 7.18 In what ways are the views and preferences of the local population being sought?

What training is being provided to them?

What means are open to them to influence the planning and operation of the Project?

S 7.19 Additional socio-economic information and list of reports/references consulted.

S 8 **Human Health**

The following questions should be asked to senior medical staff serving within the Project region.

Name

Official position

Name of establishment for which you are responsible

Type of medical facility (hospital/clinic/etc)?

S 8.1 Number of people served by your establishment?

Situation of population (as % of those served)

	Without the project (%)	With the project (%)
Close to irrigated land		
Close to permanent rivers		
Close to lakes, pools or reservoirs		
Close to floodplains, swamps or wetlands		
In recent settlements		

S 8.2 Give information about water related disease in the region:

Disease	Disease never occurs	No available information	No. of recorded cases last year	Approx % of population believed to have been affected last year
<u>Water borne</u> Cholera Bacterial dysentery Typhoid Amoebiasis Other				
<u>Water washed</u> Ascariasis Other				
<u>Water based</u> Schistosomiasis Dracunculiasis Other				
<u>Insect vector-borne</u> Yellow fever Dengue fever Rift valley fever Encephalitis Encephalomyelitis Leishmaniasis Lymphatic filiarsis Loaiasis Onchocerciasis Other				
<u>Faecal disposal related</u> Ancylostomiasis Other				

S 8.3 Give details of existing or planned control programmes for any of the above diseases

Disease	Method of control	Year control began/planned	Who is responsible	Annual cost	Remarks on effectiveness

S 8.4 Describe existing programmes of regular health education, birth control, vaccination and treatment in villages.

S 8.5 How many people are employed in this work?

S 8.6 Will new villages in the Project be included?

S 8.7 Will extra staff and money be made available for this work?

S 8.8 List the diseases in S 8.2 which you consider most serious in this region

Name of disease	Reasons why (eg number of cases/disability caused/deaths caused (give no. if known)/other	Is the disease more serious among people living near irrigation?

S 8.9 List other diseases which in this region are equally serious or more serious than those in S 8.8

Name of disease	Reasons why it is a serious concern

S 8.10 Describe any other health risks which occur in the region as a result of agricultural/irrigation activity (poisoning with agro-chemicals, farming accidents, pollution of water sources, etc). Estimate the number of cases per year if possible.

S 8.11 Additional health information and list of reports/references consulted.

S 9 **Ecological imbalances**

S 9.1 What are the main pests or weeds which threaten crops in the Project and what method of control is used or envisaged? (Compare with nearby existing projects with similar crops.)

Name of crop pest or weed	Method of control (name chemicals if known)	Person responsible for control?

S 9.2 What aquatic weeds threaten the reservoirs and irrigation and drainage system of the Project and what method of control is envisaged? (Compare with nearby existing projects.)

Name or type of weed	Part of system affected	Method of control (name chemical if known)	Person responsible for control?

S 9.3 What land animals, birds or aquatic animals are favoured by conditions created by the Project to become a nuisance for the Project or the population? (List disease vectors under S9.6)

Name of animal	Impact on Project or population

S 9.4 Name any animals, livestock, crops, plants, trees or other species introduced as a result of the Project which are not native to the region and might cause ecological imbalances.

S 9.5 List water-related and other diseases of domestic animals which may increase due to the Project.

Name of disease	Reason why it is of serious concern

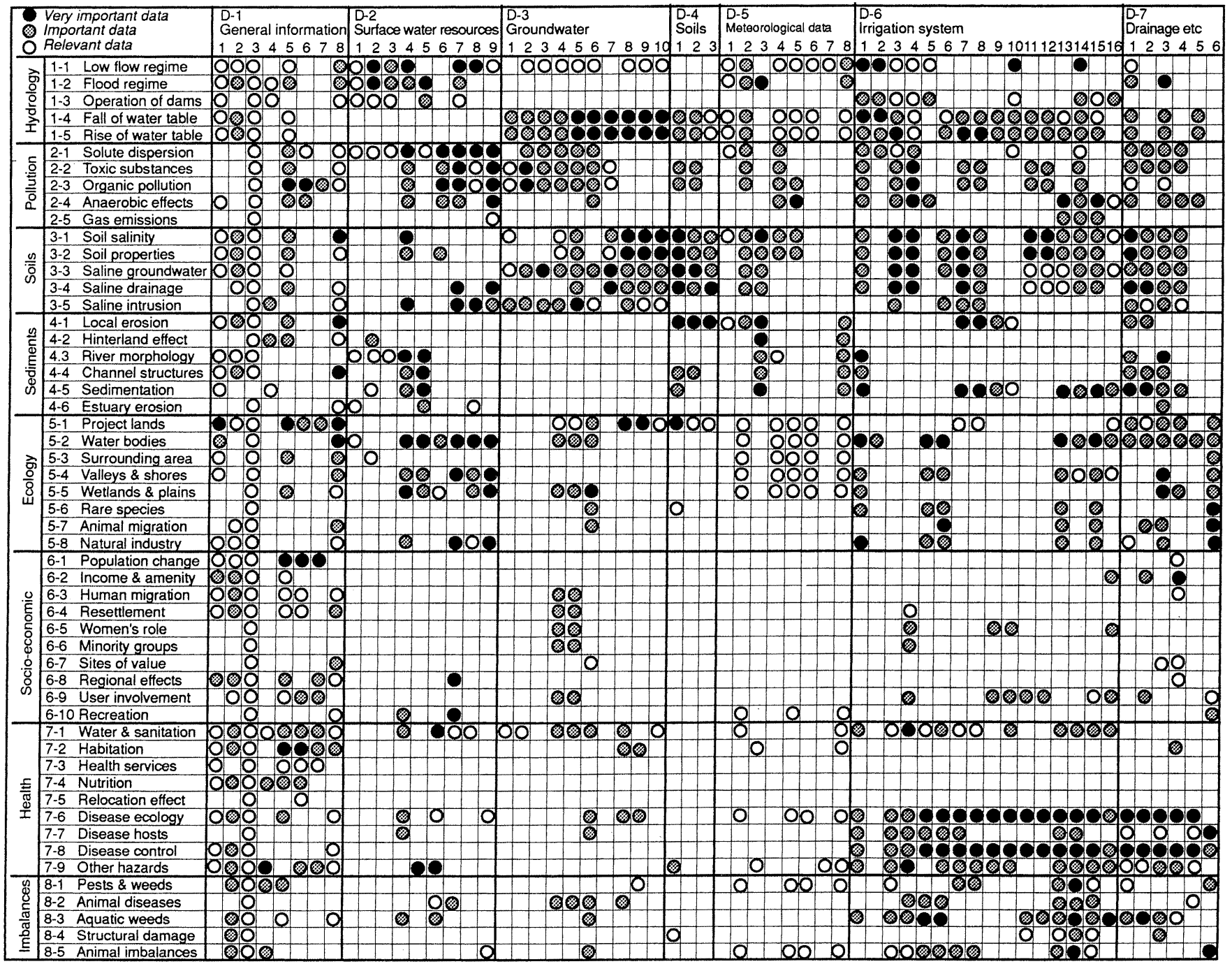
S 9.6 List the vectors or reservoir hosts of human or animal diseases which are prevalent in the region or may be introduced as a result of the Project.

Name of vector or host	Name of disease	Effect of Project on distribution of vector/host

S 9.7 Additional information on ecological imbalances and list of reports/references consulted.

Appendix 5

LOOK-UP TABLES SHOWING LINKAGES


Very important data
Important data
Relevant data
D-1 General information
D-2 Surface water resources
D-3 Groundwater
D-4 Soils
D-5 Meteorological data
D-6 Irrigation system
D-7 Drainage etc
Hydrology
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1-2 Flood regime
1-3 Operation of dams
1-4 Fall of water table
1-5 Rise of water table
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6-5 Women's role
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6-7 Sites of value
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6-10 Recreation
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7-3 Health services
7-4 Nutrition
7-5 Relocation effect
7-6 Disease ecology
7-7 Disease hosts
7-8 Disease control
7-9 Other hazards
Imbalances
8-1 Pests & weeds
8-2 Animal diseases
8-3 Aquatic weeds
8-4 Structural damage
8-5 Animal imbalances

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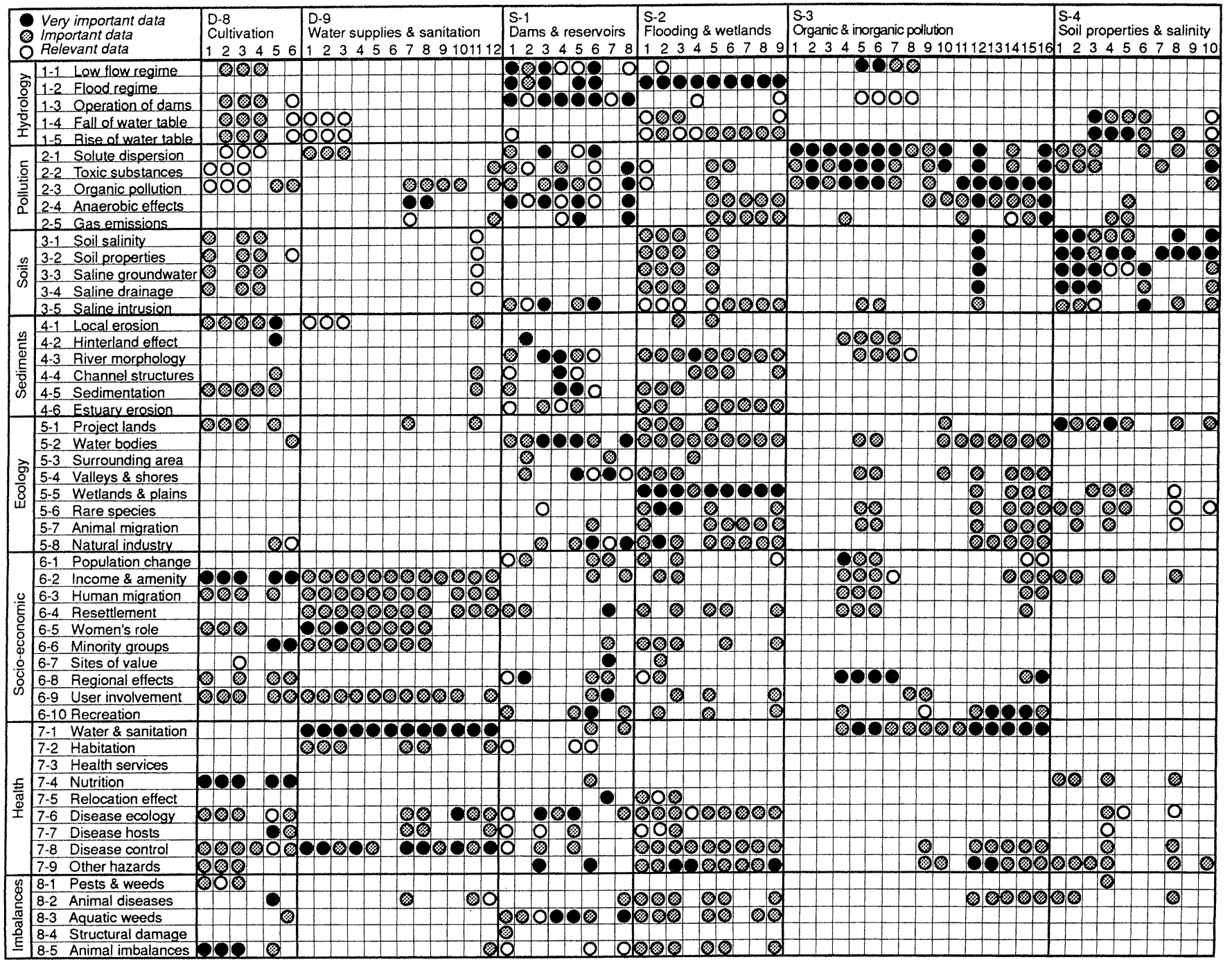
Very important data
Important data
Relevant data
D-8 Cultivation
1 2 3 4 5 6
D-9 Water supplies & sanitation
1 2 3 4 5 6 7 8 9 10 11 12
S-1 Dams & reservoirs
1 2 3 4 5 6 7 8
S-2 Flooding & wetlands
1 2 3 4 5 6 7 8 9
S-3 Organic & inorganic pollution
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
S-4 Soil properties & salinity
1 2 3 4 5 6 7 8 9 10
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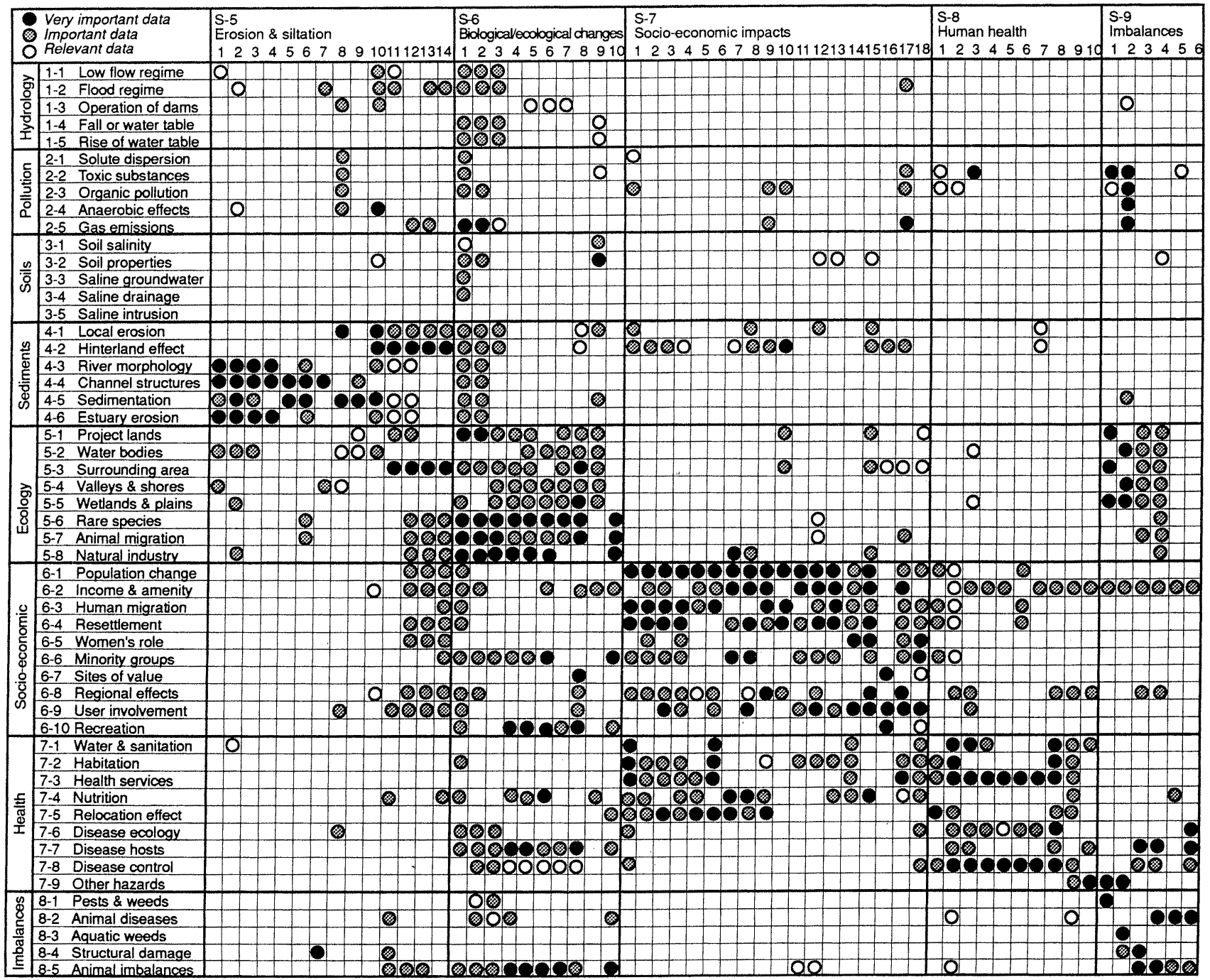
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Important data
Relevant data
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S-6
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S-9
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