Delft, 11 July 2001

To all participating organizations in the RTE-project

Dear friends,

Please find enclosed a first attempt to satisfy both our own research collaboration interest and the European Union guidelines for proposals. There is still some work to be done on the proposal. Could you please read the proposal carefully and give as much comment as possible, in as much detail as possible. Especially comments on the implementation of the project, the methodologies and planning used, are welcome.

As you can see, we have taken the liberty to suggest a certain contracting structure and a division of labor in the project. Based on the information we had about your organization, we tried to work out a manageable division, which would serve the project outcome. We ask you to comment on the appropriateness of our proposed division of labor.

Furthermore, we ask you to provide a description of your organization, a proposal of your contribution (persons, budget, timing), information about the persons involved, including a maximum of five key publications or patents (if appropriate). Please note that we need your input in months of work, and that it is necessary to use controlable rates per unit of work. The EU will control the financial aspects of the project quite heavily, and all the financial aspects should be defendable.

This week we will send a pre-proposal check to the EU, and we expect comments back before the 25 of July. We would highly appreciate it if you would be able to give feedback on the concept-proposal enclosed with this letter before the same date.

We wish you the best of luck with the proposal, and look forward to your reactions and input. Together we will make sure that we produce the best proposal and research project the EU has ever seen!!

Looking forward to meet you in the near future,

kindest regards,

Maartje van Westerop
Theresia Twickler
Maurits Ertsen

Part B Description of the research work (anonymous)

Rehydrating the earth

Systems research on small groundwater retaining structures under local management in arid and semi-arid areas of East Africa

Proposal acronym **RTE**

Region (please use codes as described in section IV.3.3 "Keywords" of the Guide for Proposers, part 2). **Kenya and Tanzania**

Research area: a combination of **a.i, b.ii-2, c.iv**

B2. Objectives

Introduction

Soil and water conservation is a high priority in sub-Saharan Africa, especially in the drier areas. In these (semi-)arid regions rainfall is seasonal and highly erratic. Storage of water from the rainy season to the dry season, or even from wet years to dry years, is highly important in such regions. Superficial storage, however, has some drawbacks, such as high evaporation, contamination danger and taking valuable land out of production. Using the sub-surface to store water is another option. Through the application of groundwater dams, which obstruct the flow of groundwater and store water below the ground surface, existing aquifers can be repleted or new, shallow aquifers can be created.

Many projects and policies have been implemented to improve the conditions of land and water in the areas, but much policy has failed because it did not recognize the location specificity of conservation problems and solutions in sub-Saharan Africa and the inapplicability of imported methods without adaptation. In response to this failure, approaches that do try to take into account local conditions (material and immaterial) have come to the front, under the umbrella concept of participatory design. Some successful examples are available, but in general the approaches have been limited to (1) the level of individual farms (focusing on cultivation), using communities as medium for exchange, or (2) the theoretical level, giving ample debates on how to do it, without actual results in the field.

General objective of the research

The general objective of the research project is

> to clarify the relations between local practices and theoretical approaches, by focusing on the design, management and performance of small groundwater retaining structures on a communal level in semi-arid regions in two African countries, Kenya and Tanzania, linking both the individual and the community as theory and practice, resulting in guidelines for participatory design of small water retaining structures in semi-arid regions worldwide.

The project will investigate the different parameters for success of the Kenyan systems, with respect to technological possibilities sustained by social, economic, organisational and managerial factors of the communities and local government. The outcome is tested parallel in the Tanzanian area. Results in both areas will lead to the production of a manual for design, operation and maintenance of small water retaining structures, with focus on local management and community participation. Attention points for spin off and diffusion, applicable to (semi-) arid areas stimulate implementation on a wider scale.

Specific scientific and technological objectives

1. Clarification and further implementation of the participatory design approach for small water retaining structures in the research areas;
2. Clarification of the performance of small water retaining structures, including aspects concerning hydraulics, hydrology, water use and health;
3. Development of a systems' perspective on design, management and performance of small water retaining structures in semi-arid areas;
4. Development of a participatory design approach applicable in other regions for comparable small water retaining structures;
5. Education and training of staff, students and local communities involved through exchanges in workshops, field visits, formal education and networks;
6. Dissemination of the project results through a manual (scientific book), a number of scientific papers and conference proceedings.

Section B3. Contribution to the programme objectives

Deliverables

The research aims to contribute to at least three of the formulated deliverables in the call:

- Improved systems of renewable natural resources use in rural and urban areas and improved health systems;
- Cost-effective tools for improved health, agricultural and agro-industrial production and water management;

- Strengthened research base in Europe and Developing Countries, including training and institutional development.

The research project focuses on the (semi-)arid areas in Eastern Kenya and Northern Tanzania. In these regions rural and pastoral activities intertwine with nature conservation, providing complex interactions and competition between users of natural resources involved, especially land and water. Within a setting of demanding natural circumstances (semi-aridity and drought), growing pressure on natural resources (competing demands for scarce water) and difficult economic conditions (including labor migration), there is a urgent need to improve the local conditions. The research builds on experience gained in local development activities, both from partner organizations and other sources, and will extend these experiences in new areas to confirm and establish the approach. The learning process in developing and organizing water related activities is accelerated by establishing networks to strengthen and/or create links between partner organizations. Networks will be employed on four levels:

- networks within local communities;
- regional networks, involving representatives of partner organizations;
- national networks, usually involving representatives of many partner organizations;
- international networks, involving representatives of partners of different countries.

Within the group of partner organizations in the research project, potential networking activities and representatives on all levels are present. Many partners are involved at different levels, and thus provide the necessary links between these levels of networking.

Levels of research

The EU-call for proposals envisages an integrated scheme of three levels of research:

a) Policy research to determine the conditions for sustainable development, including gender issues involving the state, market forces and civil society;
b) Systems research on complex issues involving many interacting components, such as, rehabilitation and management of renewable natural resources or health care; and
c) Research on specific scientific and technological problems to generate tools for sustainable development, which can be used in a particular context of system management or policy development.

Without the claim that this research will concentrate in depth on all three levels, they are all included. The focus is on level b: study the complexity of design, management and performance and develop an integrated, participatory design approach for small water retaining structures. To do this properly, however, issues from the levels a and c, have to be covered, such as community involvement (in which the gender component is crucial) on level a, and structural and hydraulic aspects of water retaining structures on level c. Such an approach includes a process of thematic concentration, which is mentioned in the research call: policy research covering strategic sectors (in this research proposal water source development and community involvement), systems research narrowing to natural capital (groundwater hydrology, semi-arid regions) and the human environment (management and design, socio-economic context, water use and health), and tools research focussing on specific key items (dam stability, hydrological performance).

Priorities

- Teaching and learning processes, taking into account new, existing or traditional knowledge, and ways to integrate these different knowledge sources to support sustainable development (a.i);
- Management of local water resources, to ensure hygienic conditions, multiple water use, and to prevent pollution of and pressure on existing water resources (b.ii.2);
- Safe and efficient water management through low-investment and ecologically suited technologies (c.iv).

Section B4. Innovation

The technology

Groundwater dams are structures that intercept or obstruct the natural flow of groundwater and provide storage for water underground. Damming groundwater for conservation purposes is not a new concept. Groundwater dams were constructed on the island of Sardinia in Roman times and structures in Tunisia show that damming of groundwater was practiced by old civilizations in North Africa (Nilsson 1988). More recent efforts, in the 1980's, include small-scale groundwater damming projects in many parts of the world, notably India, Africa and Brazil. Use is in areas where flows of groundwater vary considerably during the course of the year, from very high flows following rain to negligible flows during the dry season. The basic principle of the groundwater dam is that instead of storing the water in surface reservoirs, water is stored underground. Evaporation losses are much less for water stored underground. Further, risk of contamination of the stored water from the surface is reduced because as parasites cannot breed in underground water. The problem of submergence of land which is normally associated with surface dams is not present with sub-surface dams.

The technology is not new, but unfortunately many of the development programs in which the technology has been implemented were not new either. Much actions have failed because they did not recognise the location specificity of conservation problems and solutions and the inapplicability of imported methods without adaptation. Many schemes have been executed as isolated pilot projects, with the apparent purpose of encouraging imitation by local actors. In response to such failures, approaches that do try to take into account local conditions (material and immaterial) have come to the front, under the umbrella concept of participatory design. Some successful examples are available, but in general the approaches have been limited to (1) the level of individual farms (focusing on cultivation), using communities as medium for exchange, or (2) the theoretical level, giving ample debates on how to do it, without actual results in the field.

Participatory design

Participatory approaches start with the community. The community must define its problems, set its priorities, and make the decisions on how to solve them. External organisations, like NGO's are a catalyst or facilitator. Such an approach recognises that local people in a given area know the problems they face more in detail than anyone else, know the natural and human resources available, and know what may or may not work in a given situation. By encouraging the local community to seek its own solutions rather than imposing solutions from outside, the initiative, knowledge and talents of the people are released, the community is empowered and the likelihood that development measures will be sustained is greatly enhanced. It usually gives women, who generally carry the greater burden of feeding the family, rearing the children and maintaining the home, the chance to participate on an equal basis with men.

In Eastern Kenya, in the Kitui and Tsavo regions, several groundwater structures have been built in the last 6 years. In Tsavo East National Park, a co-operative effort of the several organizations resulted in 10 small dams to conserve water for wild-life. The impact on vegetation, although not yet studied systematically, is already showing. In Kitui (north of Tsavo), more than 200 dams have been built in close co-operation between a local NGO and local communities. These dams are in full use. Private local initiative organised in the NGO has mobilised communities, assisted them in building dams and connecting water wells, advises and assists them in reforestation and terracing for better agricultural use of the land while at the same time offering beginnings of research and training for management and proper use of the new water resources and health issues. The aim of this research project is to link these local experiences on design and performance of groundwater dams, both the individual and the community based ones, with scientific theories on participative design and research, resulting in guidelines for participatory design of small water retaining structures in semi-arid regions worldwide.

Debates of innovation

In short, the research studies the possibilities for extending a reference approach to other regions with similar conditions and needs. What is significant about the reference approach is (1) making the demands and knowledge/experience of the community the starting point, and (2) aiming to create and study a network of water points (including shallow wells and sand dams, supplemented by roof and rock catchment and other sources). The project adds two extra dimensions: (3) exploring relations between practice and theory (including academic learning and training (WP4)), and (4) exploring the relations between design (WP2) and performance (using a system approach, WP3)). All this effort should result in a action oriented, participatory, systematic and scientifically sound design approach (WP5), interesting for the project members, graduates and water development programs world-wide.

- **Local versus scientific knowledge**

Because of the failures of the 'scientific' approaches to development problems, the power of 'indigenous' knowledge has been stressed by many contributors to the discussion. Scientific approaches (or technological-scientific approaches for that matter) would be inherently insufficient to deal with the diversity and specificity of local practices, let alone to improve these practices. Much of this apparent fundamental difference, however, has a highly practical dimension and relates to the different spatial and temporal focus of the different systems. Usually, scientific theories and laws are only valid in abstract and/or idealized situations and are not meant to be applicable to concrete every day situations. Local knowledge on the other side particularly is based on the every day situation, and can be highly successful in coming to terms with them. To be able to link with local practice is not impossible for science, but needs a focus on further translation of scientific knowledge to the local situation. In such a way, scientific approaches and technologies can contribute to new and improved processes of local practice and learning. This research project will link local and scientific knowledge about groundwater management and dam design, and will at the same time link theoretical debates (science) and local design activities (practice) on knowledge and participation.

- **Integrated system analysis**

Projects designed to improve water resources in these areas should take into account a number of related aspects. One issue could be labelled social, as it centers on the question who uses the water. The answer to this question has immediate implications for the design. For example, there is a clear functional difference between sub-surface dams and sand-storage dams in terms of water use. Usually sand-storage dams are used for the provision of drinking water, and not for irrigation. About half of the sub-surface dams on the other side documented by Nilsson (1988) supplied water to irrigation. The figures of stored water explain this difference. Sub-surface dams can store larger quantities, as they can dam existing aquifers. However, negative aspects on environment and local development of larger dams have been widely advertised, and local initiatives on building small sized water-retaining structures to retain water for human, animal and agricultural purpose have proven to be highly successful. These dams retain the little amount of water streaming down the rivers, improving plant life and thus agricultural opportunities around its banks. Existing economic activities are sustained and new economic activities are able to emerge, but only on a local scale. Nevertheless, economic stability is the most important incentive for local households to stay in the area instead of leaving to seek better opportunities in the cities. The research project will use a system analysis to link all these issues, and provide both practical outcomes and theoretical implications of such an approach.

- **Creating capacity**

Designers have an important role in participatory design processes: besides bringing in technical expertise, they should also be able facilitate discussions and decision making by the actors involved. Participatory design approaches demand designers that are better prepared in communicative skills, but also in technical knowledge and design experience. Designers need creativity and technical abilities to deal with a variety of types of knowledge, demands, criteria and options: design capability. The concept of 'design capability' (Van der Ploeg 1991) is defined as the art to transform specific circumstances and problems with the help of scientific insights into new solutions. Integrating both the local context and the scientific issues relevant for a problem, design capability can result in new technologies every time it is employed. The trend has been rather the opposite: once a specific technology has been designed and constructed, this technology starts to figure as the latest and thus the best solution for all sorts of problems. The design capability that is used is 'frozen'. In case a technology does not fit too well in other situations attempts are made to change the situation in such a way that the technology becomes applicable. Development aid is a notorious example of this approach. Creating 'design capability' and the abilities to establish a set of relevant conditions from a complex of social, economic and technical variables in an interactive process with the parties involved asks for a renewal of design education. This research project will build on educational programs that provide the necessary training and learning for students, staff and interested participants.

Section B5. Work plan

Introduction

The project work plan is based on a number of connected elements:

- Clearly there is no single solution to the problems of water supply and distribution, and there is much to commend an integrated approach that develops different sources to meet a variety of needs. The project focuses on an existing participatory approach for the construction of small water structures, mostly sand dams in combination with shallow wells.
- Both existing as new situations in which the chosen constructions have been designed and/or are in use will be studied. Some through a literature survey, some through field visits, others through participatory design, construction or research.
- The study into the performance of groundwater dams focuses on the constructed dams in Kitui area, formulates recommendations for dam and water management and supports the implementation of these recommendations.
- Integration and testing of results is studied through the construction of a few new sand dams, in other parts of Kitui, in the pastoral area of Amboseli, Kenya and in Ngorongoro area in Tanzania. Recommendations from these experience will be brought into the discussions.
- Throughout the whole project, participating members will meet twice a year during a workshop. Students from participating universities are encouraged to take part in the project within their formal training. PhD-students from Kenya and Tanzania will be involved as well.

Sand dams

Sand dams have come to assume a central role in the Kitui programme of water development. They can store sufficient quantities of water for livestock and minor irrigation as well as for domestic use, and the cost per cubic metre of water stored is very much less than that for a rainwater tank. However, the quality of water can be poor unless there is an adjacent well from which the filtered water can be drawn, and the burden of transporting the water can be heavy. If properly sited and built, sand dams can be a

welcome water source. There are also unfortunately many examples of groundwater dams which have not been successful. Therefore, a number of aspects have to be dealt with to find out whether a groundwater damming solution is adequate for a certain region:

1) The hydro-geological conditions at the site have to be known. Proper investigations have to be carried out, but as the dams and the volumes of water usually are relatively small, costs of research should be kept to a minimum. Thus, investigations have to be simple too.
2) Caution is also needed when the construction itself is considered. As costs should be kept low, the choice of materials, building methods etcetera, is limited. At the same time, the dam should have a certain quality, and be durable to withstand water pressures and sediment loads.
3) The importance of local management is recognized nowadays as a prerequisite for long-term use. Local management does not start after construction but during design and construction.
4) The performance of existing groundwater dams in different regions provides at least starting points to consider the application of the water technology in new areas.

In short, sand dams are an option, if locally adapted and cheap (with the two related). In combination with the demand for local management (including local monitoring of performance) one easily recognizes the need for participatory approaches, in which knowledge and experiences of parties involved are exchanged and integrated.

Documenting experience

In 1994, the Kitui NGO adopted the participatory approach to development, drawn on experience from participatory activities in neighbouring Mwingi District. It developed educational materials for community training, procedures for assessing the impact of the project, and improved methods for accounting, planning, monitoring and evaluation. Communities are mobilised through Participatory Rural Appraisal (PRA). The community selects from 25 to 50 trainees, both men and women. The training lasts from five to eight days and follows a well-defined pattern. At the start, the trainees appoint individuals from within their group to take responsibility for timekeeping, recording, controlling discussions, organising meals, and so on. The first activity is to prepare maps to show the social setting, the resources of the area and other aspects of importance. A second activity is to collect basic information. Another activity is to prepare a time line showing major events such as droughts, famines or floods against a chart of years. This leads naturally to an analysis of trends, and it changes when participants record their observations on changes in population, land use, fertility of the soil, availability of food, water fuelwood and so on. Although not everything can be quantified, a consensus among the people about what is happening to their environment is a powerful tool in reaching agreement on priorities for development. All this baseline information provides a point of reference for future comparison after developments have taken place. It will be the task of the project to extend the baseline information to a more systematic and generally applicable knowledge base. The research will draw data from sampled households in the project area in Kenya. A representative number of dams will be sampled using stratified random sampling technique based on eight catchment areas. For the purpose of obtaining a comprehensive picture of social and economic conditions and impacts of the sand dams, the inter-method triangulation approach will be adopted (application of both qualitative and quantitative methods in data collection). The construction of the survey instrument will be done in four stages. First, a desk study on all available past research will be done. Data on local production, collected by community groups will be analysed. Secondly, a participatory research methodology will be employed using the Methodology for Participatory Assessments (MPA). In the third stage, a limited number of questionnaires will be administered to elicit information from the sampled households in the catchment area while in the fourth level, Focus Group Discussions will be held to amplify and confirm the emerging issues. Data analysis will employ both descriptive as well as econometric regression analysis. This will yield both descriptive and inferential statistics that will be used in making predictions and conclusions necessary to answer the study questions. Probabilistic variables will be analysed using discrete choice of methodology.

Experimental sites

Next to documenting existing practice, the project will study the implementation process of new water structures in three other areas, two of which are in Kenya and one in Tanzania. All three areas are located in the semi-arid zone, but differ from each other regarding other aspects.

- **Kitui, Kenya**

The current NGO program plans to extend the activities to other (less populated) parts of Kitui district, to test the technologies in different soils and gradients and in different social structures. Besides these already challenging circumstances (with a much lower water table and decreasing slopes of the river, causing meandering and wider beds), two other typical difficulties will be encountered. In view of the out-migration of a large section of the able-bodied men in search of employment, communal work will be harder to organise in the lower and drier areas where population densities are less than 100 persons per km^2. A second problem that does arise, in relation to the expansion of towns is increasing water pollution due to small industries and urban waste. A shallow well adjacent to a sand dam will improve the quality of water by filtering out dirt, but to what extent has to be studied.

- **Amboseli, Kenya**

The Amboseli landscape is dominated by the Kilimanjaro, backdrop to an area where the pastoral Masai and their cattle live together with the wildlife. Although the Masai are in a way caretakers for the wildlife in Amboseli too, the establishment of wildlife reserves did take away rich lowlands and drought refugees. The present day Amboseli National Park was established about forty years ago as a sanctuary for the remaining elephants. The park embraces two large, spring-fed swamps, in a region that receives only 12" (300 mm) of rain a year. For the pastoralists, however, water availability has become a serious problem, especially since the droughts of the 1990's. Given the success of groundwater dams in another national park (Tsavo East), the research project will include this area to study the implications of dam development in such circumstances.

- **Ngorongoro, Tanzania**

Ngorongoro is a microcosm of East Africa. The land of the Masai, of their cattle, of the fauna, this protected area is located in the Great Rift Valley. The area is managed by the Ngorongoro Conservation Area Authority NCAA) and they try to balance the needs of the wild animals, the local Masai people and their domestic stock and the general natural environment. The research project focuses on the Karatu Arusha Region. Some 200 km. west of Mount Kilimanjaro, Karatu lies on the plateau above the Great African Rift. The plateau and steep rifts cause considerable erosion in the rainy season, and the heavy waterflows disrupt cattle and farming land. Although Karatu is located between the Ngorongoro Conservation Area, Manyary National Park and the Eyasi and Manyara soda lakes, the area is not governed by the NCCA and the local communities have to find solutions for themselve.

Adequacy of chosen approach

Justify the choice of approach and main techniques to be used, identify any potential problems, commenting on the technical feasibility of the methodologies and the level of risk associated with the project.
Maximum length: two pages.

Three elements to be explained

- Learning from experience
- Learning from experiments

- Integration of scientific and community learning

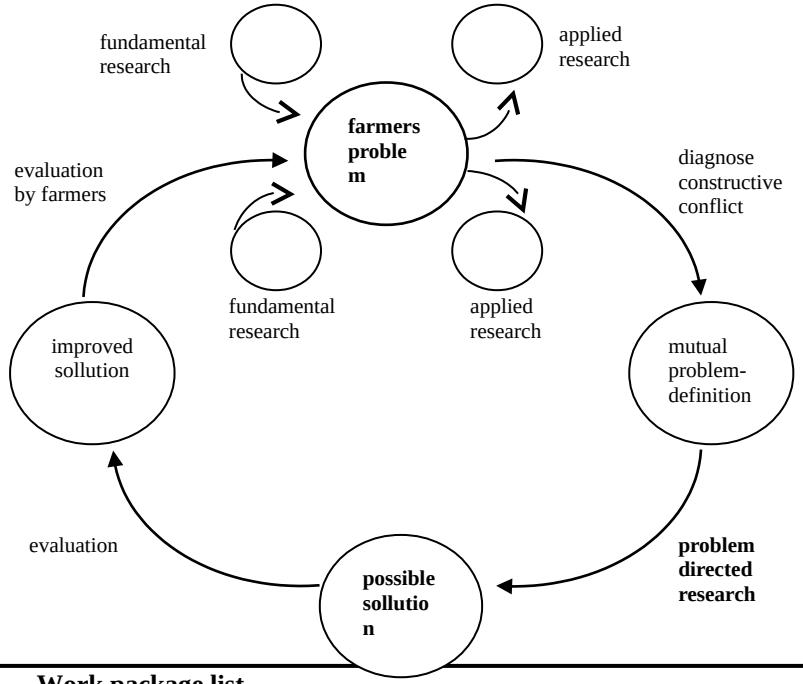
The construction of sand dams has impact on the community, on agriculture and on the environment. For many aspects, quantitative data are lacking. The people who are best able to evaluate the success or failure of a project are the people on the ground – the beneficiaries. The achievements in improved quality of life, changed attitudes and empowerment of people is difficult to measure, but the comments of individuals give some indication of what has been achieved. Systematic research is necessary. The most immediate impact of the construction of a sand dam or a shallow well is improvement in the availability of water. Construction of sand dams impedes downstream flow and recharges the riverbanks, from which water returns as the dry season proceeds. This has the effect of maintaining a steady water level for longer. When the usual water sources dried up, people had to go farther and farther afield to find a river where water is still available. The time and energy employed in fetching water diverted attention from other tasks. The impact of sand dams on health has already been recognised by some women but will be more noticeable as wells are constructed and the risk of pollution is reduced. The quality of the water from these dams has so far not been investigated. There is a need to investigate the (bacteriological) quality of the water and relate this to the water management and use patterns of women and men user groups, in view of the longer-term health benefits of the provision. This research can only be done in cooperation with the users, as they are also directly maintaining and managing the source.

The impact on the environment starts with, that raising the bed level of the river by installing dams reduces the erosion of the riverbanks and of the water courses leading into the river. Also, raising the water table encourages vegetation and agriculture along the riverbanks and improves the stability of the banks. More information on this should come from the environmental studies currently under way. The biggest question to answer is what is the impact on river flow. Preliminary data seem to show that there is more water downstream than in the past as the overall flow is slowed. No doubt, observations of the local people will answer many of these questions in time, but it will be important for future planning to have a systematic record of what changes take place in stream flow and water storage as a result of sand dam installation. The impact on agriculture takes several forms. Tree nurseries have been established close to the dams and wells so that seedlings are now available, or will be soon available. Time saved from fetching water is now available for terracing. The production of vegetables in plots close to the river can provide income, especially in the dry season, and lead to improvements in nutrition. Finally, improvement in the supply of water will reduce the time that livestock spend trekking to water and the risk of disease associated with the trek.

Methodologies on different levels

- Experiential learning, social learning,
- PRA
- Chemical analysis
- Literature survey
- Model studies / simulation
- Questionnaires
- …

Participation/information



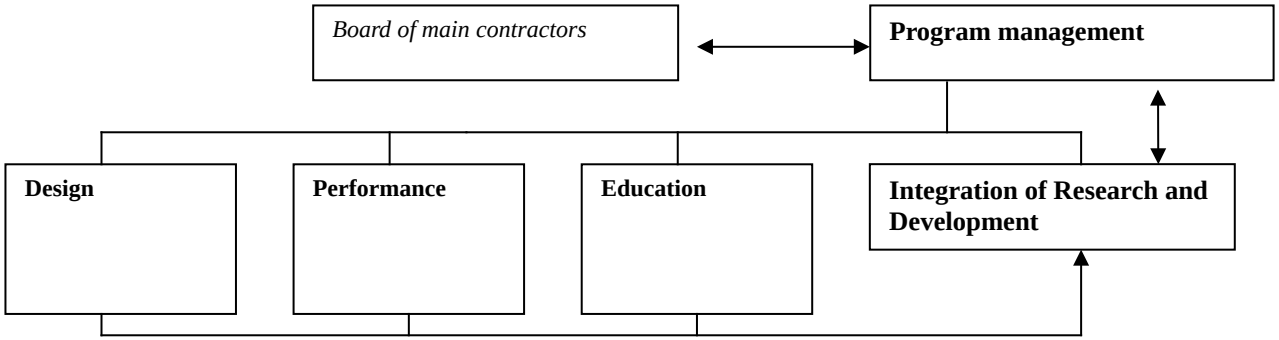
Challenges

Completing a sand dam and installing a well upstream from which clean water can be drawn opens new doors for raising tree seedlings, growing vegetables and improving health. But it can also generate new challenges. Who, for example, has the right to grow fodder grass along the riverbank? Who can have access to land for a tree nursery or a vegetable plot? Who will take responsibility if a leak appears in the dam wall, and who will ensure that the well windlass is kept in working order? The rights to water will need also need to be clarified. If a sand dam is constructed, can those who have land upstream and adjacent to the river take water out by pumping to irrigate their vegetables? And what control exists over those who might want to extract sand for building purposes?

B5.1 Work package list

Work Package No.	Work package title	Lead contractor No.	Persons-Months	Start month	End Month	Deliverable No.
WP1	Program management	1		0	35	D1
WP2	Design	6		0	23	D2-D3
WP3	Performance	4		0	23	D4-D5
WP4	Education	1		0	35	D6
WP5	Integration	10		13	35	D7
	TOTAL					

Organization of the research project, including workpackages



B5.2 List of deliverables

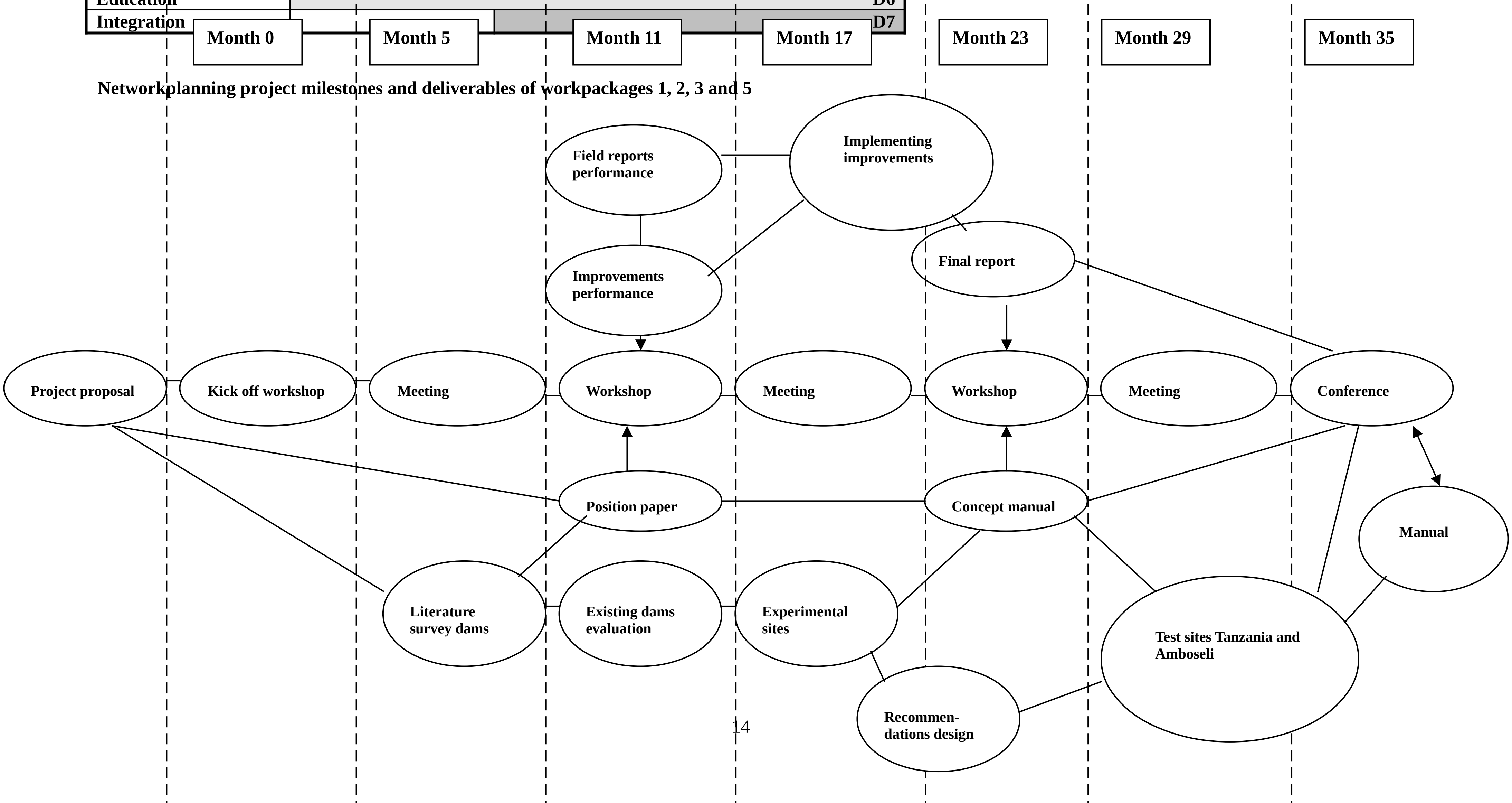
Please note, that the deliverables presented below are the 'umbrella' hard-copy products of the program. In the detailed description of the work packages, all related activities to the composition of these 'umbrella-products' are given.

Deliverable No.	Deliverable title	Delivery date
D1	Program evaluation report	35
D2	Evaluation of the design of existing sand dams	11
D3	Recommendations for future designs	23
D4	Hydrological performace and agriculture	11
D5	Water use and health	23
D6	Academic program	35
D7	Small water structures manual	35

Timetable of deliverables per workpackage

Workpackage/year	Year 1	Year 2	Year 3

Activity	Deliverable
Program management	**D1**
Design	
Existing situation	**D2**
New situations	**D3**
Performance	**D4 and D5**
Education	**D6**
Integration	**D7**



Networkplanning project milestones and deliverables of workpackages 1, 2, 3 and 5

B5.3 Work package description

W1 Program management

Work package number :	W1						
Relative start month [1] :	0						
Participant number:	1						
Person-months per participant:							

[1] Month 0 being the start of the project.

Objectives

Description of work

Type of work: communication and management

Deliverables

D1 Program evaluation report

a) Yearly report 1, including proceedings of workshop 1
b) Yearly report 2, including proceedings of workshop 2
c) Final report

Milestones and expected results

Each half year program meeting, resulting in a program update and planning

Each year a workshop

W2 Design

Work package number :	W2						
Relative start month [1] :	0						
Participant number:	6	1	5	8	9		
Person-months per participant:							

[1] Month 0 being the start of the project.

Objectives

- To optimise the design of sand-storage dams.
- To make a manual on location choice, design, construction and maintenance with emphasis on the specific problems in ASALs.

Description of work

Type of work: design oriented theoretical research, participatory research and construction

Design and construction of sand dams

The community assists in looking for a suitable site where the river is naturally confined between banks even when in flood. There should be a rock bar that goes through the riverbed and is, as far can be ascertained by probing with an iron rod, not fractured. Dams that are constructed where there is no rock bar should not exceed

0.5 m above the existing sand level. The height of the dam is usually about 1.5 to 2 m in the centre, but in a few instances dams up to 4 m have been constructed. At either end of the dam, the wall is raised to prevent the river cutting round during a flood. Where the valley sides are flat, wing walls may be added at an angle to the main dam for the same purpose. Each site is different, and the design has to be modified accordingly, but the basic principles are straightforward. Once a site is selected, a trench is excavated down to the rock bar. The wall is normally constructed with a base width of 150 cm and a top width of 75 cm. The upstream side is vertical and the downstream side angled. The success of the work depends on careful attention to detail. All rocks must be washed before use. Sufficient spaces must be left between them to ensure that they are properly bedded in the mortar, which should be well mixed in the correct proportions of sand and cement. The mortar that is used for filling the middle should be wet enough so that it can be properly packed into the gaps around the hardcore. Keeping the structure wet during construction and allowing proper curing for three weeks afterwards is particularly important because of the hot sun and dry conditions that usually prevail. Women make a major contribution to this effort, for more often than not they have to walk from 1 to 10 km to fetch the water.

The success of the project depends foremost on the quality of workmanship that the artisans show. Rivers vary in width and discharge. Rock foundations vary in depth and susceptibility to leakage. Riverbanks may be high or low, and the need for wing walls has to be carefully assessed. If a sand dam has been well constructed, there should be little or no maintenance. However, it is necessary to check after floods and repair any damage that is found. Most of the completed dams withstood the exceptional rains and floods that occurred in 1997 and the first half of 1998. In a few instances, the river cutting round one edge damaged the structure. This showed that the wall should have been higher at that point or that the barrier should have been extended with a longer wing wall. Construction of sand dams in stages, with the dam being heigthened about half a metre per year, is sometimes recommended. This method is said to ensure that only sand is deposited and the silt and fine particles, which could otherwise reduce the storage capacity, are carried on downstream. This procedure has not been adopted because of the cost and the problems that would be involved in mobilizing the community on several separate occasions. Experience so far indicates that there is minimal deposit of sediment other than sand.

Problem definition

In 1997, a workshop was held at which the artisans were given the task of preparing guidelines for design and construction in which they combined technical information with their own knowledge and experience. Still, there is a lack of knowledge base on the technical background of sand-storage dams built. This lack of knowledge hinders further optimisation of the dam design. There is also a lack of documentation about the design and the building process of sand-storage dams so that copying of this technology for water infrastructure for other development organisations or governments is difficult. The most important findings from a first evaluation are:

- A main weak point, erosion, is caused by the way the river flows across the dam. If the discharge is high, the water flows across the wings and causes erosion nearby wings, banks and toe of the embankment.
- The lack of a stilling basin that prevents the downstream toe of the dam gives the erosion full play to damage the foundation of the dam.
- Planting vegetation prevents erosion. Napier-grass has proved its suitability. The non-permanent rivers are wild and have a high flow velocity. Planting Napier-grass can fix the course of the river.
- The reservoirs are not yet protected against contamination by cattle or other contagion sources. To prevent contamination of the water in the reservoirs cattle should not be allowed to walk in the reservoir.
- Although some dams show cracks and/or seepage, the dams are still able to retain water in their reservoirs.
- To be able to design a sand-storage dam the peak-discharge must be determined. Methods based on peak levels, such as the Slope-Area Method, are often used in areas where no data is available. This method is simple and gives a quite good approximation of the peak discharge. The Slope-Area Method is the most suitable method to estimate the peak discharges, because it is simple and generally applicable.
- Building in stages is recommended, since building in stages gives better sediment in the reservoir and thus more storage capacity and a better extractability of the water from the reservoir.
- The erosion of the banks and the soil directly behind the wings is caused by wrong spillway dimensions. The dimensions of the spillway are calculated using the design-discharge from the Slope-Area method.
- The stilling basin protects the downstream side of the construction against erosion. The dimensions of the stilling basin depend on the design discharge and the crest level of the spillway.

Studies

Deliverables

D2 Existing dams
a) Evaluation report of Kitui and Tsavo sand dams
b) Literature review of sand dam construction
c) Evaluation of reference site (Machakos, but preferably in Europe too, Spain, Italy)

D3 Recommendations
a) Recommendations for improvement for Kitui sand dams
b) Field report for Tanzania site
c) Field report for Amboseli site
d) Concept design manual for sand dams in semi-arid areas

Milestones and expected results

Year ½ Literature survey

Year 1 Existing dams in Kenya and preferably an other country

Year 1 ½ Experimental site Tanzania study

Year 1 ½ Experimental site Amboseli study

Year 2 Recommendations

W3 Performance

Work package number :	W3						
Relative start month [1] :	0						
Participant number:	4	2	6	10	5	7	9
Person-months per participant:	2	2	1	2	2	2	1

[1] Month 0 being the start of the project.

Objectives

- To assess the (biological) quality of the water at all points between source and cup;
- To assess the influence of sand dams on the hydrological functioning of the natural water system;
- To investigate the water handling and source management practices for domestic and agricultural water use and relate these to the water quality conditions found through testing;
- To determine any improvements achieved in comparison with previous conditions in domestic and agricultural water use;
- To assist the user groups to plan and implement any further improvements if necessary and monitor the effect on water quality conditions, management and use.

Description of work

Type of work: participatory research, chemical analysis, hydrological network analysis

Water use

The research approach opted for this is one, whereby international and national consultants and farmer groups (male and female) work together in carrying out the research, using a participatory research design on water use and quality evaluation and management. The project will use a case study approach in **how many??** Communities that represent the various conditions in the area. A thorough knowledge of the previous and current water sources and their management is required in order to draw conclusions on progress achieved so far and possible areas for further development. The study will consist of bacteriological (and if necessary, chemical) testing of the water quality at the various relevant points from source to cup and in a sufficiently large

sample to warrant conclusions. The assessment of management and water use patterns will be done through a participatory study using PRA (participatory rapid appraisal) tools, which has the advantage of leading to increased capacity of the water users to monitor their water source. The research will further triangulation technical / scientific research for chemical and biological data with user perceptions of water quality in relation to water management and use patterns.

A research project will be designed on water quality evaluation and management within which a gender angle will be integrated as one of the social variables. Existing farmer groups (water users) will be selected to become partners in the participatory research.
The following components are foreseen:

- Preliminary design and planning of the research
- Refining the research design and programme together with the stake holders
- Comparative field data collection of sand dam / water pan water sources in different social and natural environments. Assessment of local patterns of management and use with a strong focus on how gender relations and socio-economic differences affect patterns of use and management.
- The fieldwork is started by developing the PRA tools together with the respective farmer / water user groups, to ensure ownership of the results. Assessment of experienced water quality at the source, in storage and at the point of use. Management structures and their implementation.
- Parallel academic / technical sample collection for reference material to verify relevance of the results obtained through PRA tools and MPA methodology. Water quality at the source and at the point of use.
- Analysis of the collected data in two stages: user assessment and triangulation through results of chemical and biological sample results.
- Planning of improvements, if needed, and monitoring of impacts on human practices and water quality parameters.
- A workshops to disseminate the results and to promote acceptance of recommendations in the Kenyan water sector.

Hydrology

One aspect will be research to the characteristics of the reservoir and the groundwater in the banks. Data collection for this research will take place in **which number of ??** areas where dams have already been built. The areas offer different geographical circumstances; from hilly places, with or without terraces, to relative flat areas; small steep seasonal rivers, as well as wide, flat seasonal rivers. Utooni, Machakos District will 1be used as a reference area, because terracing and agriculture, in combination with sand-storage dams has been developed to a large extent. The following issues should be included in this research:

1. Reservoir:
    - Sediment in reservoir
    - Slope of the reservoir (and what are the influences on this slope)
    - Water flow in reservoir
    - Evaporation from reservoir
    - Lateral flow in or from banks
2. Groundwater:
    - Water level during the year
    - Effects of terracing on groundwater level.
    - Optimisation of agriculture

To evaluate changes in water availability and effects of sand dams, data have to be collected on the situation before and after the building of (a series of) sand-storage dams. Especially changes in river flow and water levels in the banks ask for long-run data. The research areas will include an area where there are plans to build dams within a few years. This will be an area in southern Kitui. For the hydrologic research, rainfall data is already available. Rainfall characteristics from four stations of the last 20 years are available. Maps (1:50:000) are also available. The following hydrologic effects will be included in this research:

1. River morphology
    - Change of river morphology, with special attention to erosion of the banks
    - Erosion downstream of the dam during the filling the reservoir with sediment
2. River flow
    - Change in discharge flows
    - Change in quantity of the discharge
    - Change in water availability (from the river bed) downstream of the (series of) dams
3. Banks:
    - Changes in groundwater level in the bank

- Changes in plants and crops on the banks

Deliverables

D4 Water use and health
a) Report on relationships between sand dam water use and improvement in hygiene.
b) Report on water quality and possible relationships with patterns of water sources management and use.
c) An implemented plan for improvements by the user groups.

D5 Hydrological performance and agriculture
a) Report on hydrological effects of sand dams on the natural water system
b) Report on relationships between water availability and farming systems
c) An implemented plan for improvements in hydrological and agricultural water management

Milestones and expected results

Year 1 Field work reports (D4a, D4b, D5a, D5b)

Year 1 Plan for improvements

Year 2 Working on improvements

Year 2 Final report (including D4c and D5c)

W4 Education

Work package number :	W4						
Relative start month [1] :	0						
Participant number:	1	4	7	10	3		
Person-months per participant:							

[1] Month 0 being the start of the project.

Objectives

Description of work

Type of work: communication, project educational management, tutoring

Background

In practice, water engineering problems do not present themselves in a pre-structured way. When a problem arises, it is not directly clear how this can be formulated most adequately in engineering or research terms. The notion that practical problems are basically unspecified does not imply that they could not adequately and fruitfully be translated in a specific question. Research and engineering practice shows that a translation in 'engineering language' enables the design of many adequate solutions. At the same time, many examples show the limitations of a one-dimension approach, especially when problems become more complex. Taking into account societal demands and conditions implies that each design or research should be tuned to the situation under consideration: a designer cannot come up with a standard solution. Paradoxically, introducing such a multifaceted approach asks for researchers and engineers with even higher qualifications.

The conventional way of teaching the integrative design activity is to offer 'learning by doing' design courses, in which students are taught a kind of design methodology. Without denying the potential strength of design methodologies and encouragement to design educators to present their courses in a well-structured way, it is important, however, that students will be able to generalize from and, if necessary, to adapt the particular methodology in other contexts as well. The methodology should not become a blueprint, but be a source of

inspiration. Learning such problem-solving skills will not be sufficient for individuals to become a successful problem-solver, nor guarantee that they could tackle problems of all sorts. The process of problem solving has some very un-skill-like characteristics. Freshmen at universities use a similar problem solving process as experts. The main difference between experts and students, however, is that experts generate better hypotheses, which is not a characteristic of a skill. The correctness of the specific hypotheses, rather than any process variable, is the strongest predictor of success. The expert is an expert because he or she has extensive experience, and can apply his or her knowledge and skills to the solution of a problem.

This notion corresponds well with the conception that researching and designing is a cumulative process as experiences from other design contexts are used in new situations (also an aspect of redesigning). It does make sense for students to learn the prerequisite knowledge in the context of a problem relevant for the future profession of these students, being it in medical, engineering or other problem-oriented disciplines. Such experiential learning in a (simulated) context enables students to gain expert experience during their study.

Providing experiential learning

Scheer (Scheer 1996) introduces a model, in which the design process is conceptualized as a learning process (adapted version in figure 1). In the model, several stages of the learning process are made explicit. The separate learning cycles of engineers and users are linked to and confronted with each other. During the confrontation, learning experiences of both sides are shared, providing a basis for the joint knowledge that is required for quality design. In interactive design processes (future) users of the artifact or other product to be designed are involved explicitly in the decision making process. Organizing an interactive design process is not an additional burden for projects and agencies, but recognition of actual processes, in which users have an own responsibility and will often do other things with the designs than designers would have expected. Attention should be paid to broadening the designer's frame of reference as well as the users' in order to develop effective interaction. This model illustrates the approach taken in the educational setup for students, staff and community.

International exchange

Neem uit internationaliseringsnota over.

Exchange in learning and training

Different settings for learning in the Netherland, Belgium, Kenya en Tanzania.

Learning during workshops.

Learning during field trips.

Exchange between representatives of local communities in Kenya en Tanzania.

Research

PhD's.

Deliverables

D6 Academic program
a) Participatory design training projects for students and staff
b) Staff-exchange program
c) MSc-exchange program
d) PhD-exchange program

Milestones and expected results

Year 1 Exchange of 2 groups of students

Year 1 Start of 2 PhD's from Kenya

Year 2 Exchange of 3 groups of students

Year 3 Academic exchange agreement between DUT, NU, UDS, CUL

Year 3 Start of 2 more PhD's from Tanzania

W5 Integration

Work package number :	W5						
Relative start month [1] :	0						
Participant number:	10	1	6	4	2	Others	
Person-months per participant:							

[1] Month 0 being the start of the project.

Objectives

Description of work

Type of work: communication, writing, workshops

The manual can be of use to **Technical Universities, Consultancy firms and NGO's** in Europe and Development Countries to gear their efforts to sustainable technical methods and the needs in rural semi-arid areas.
The manual can be of use to **Wildlife Conservation Organisations** in Development Countries for rehabilitation of nature areas and addressing the human-wildlife conflict.
The manual can be of use to **farmers, pastoralists and their organisations and local authorities in Development Countries** to develop the social-economic position of their farms, communities and connect them to the urban economies in their region in a sustainable way.

Deliverables

D7 Small water structures manual
a) Manual (based on project results)
b) Discussion on the manual and results (conference proceedings)

Milestones and expected results

Start of year 2 Position paper (50 pages) on starting workshop

Year 2 Draft manual, including literature review

Year 3 Visit to Tanzania and Amboseli to evaluate 'test'

Year 3 Closing conference Participatory Design in Water Engineering, presentation of manual, proceedings

Part C Policies, partners and impact
Rehydrating the earth

Systems research on small water retaining structures under local management in arid and semi-arid areas of East Africa

Proposal acronym **RTE**

Section C2. Community added value and contribution to EU policies

Please describe how the project contributes to the policy of the EU regarding the target countries or regions of the Call, and to any other relevant EU policy.
Maximum length: one page.

EU-Policy towards Kenya and Tanzania

EU-Regional policy for Mediterranean countries

Section C3. Description of the consortium

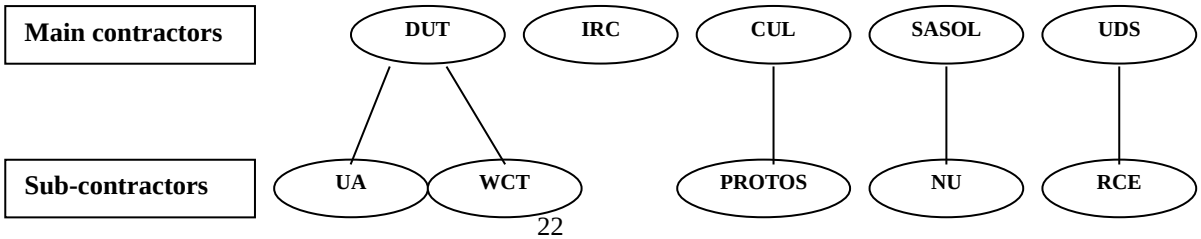
Three sets of factors have determined the consortium:
1) Countries of origin;
2) Knowledge of the participants concerning the different aspects of water development;
3) Position of the participants in the professional field.

The consortium consists of participants which together share experience and knowledge on:
a) Design issues, including technical, management and participatory aspects;
b) Performance, including hydrological, water use (agricultural and domestic) and health aspects;
c) Education, including training of students, staff and farmers;
d) All are involved in the integration of science and practice, or in other words research and water development.

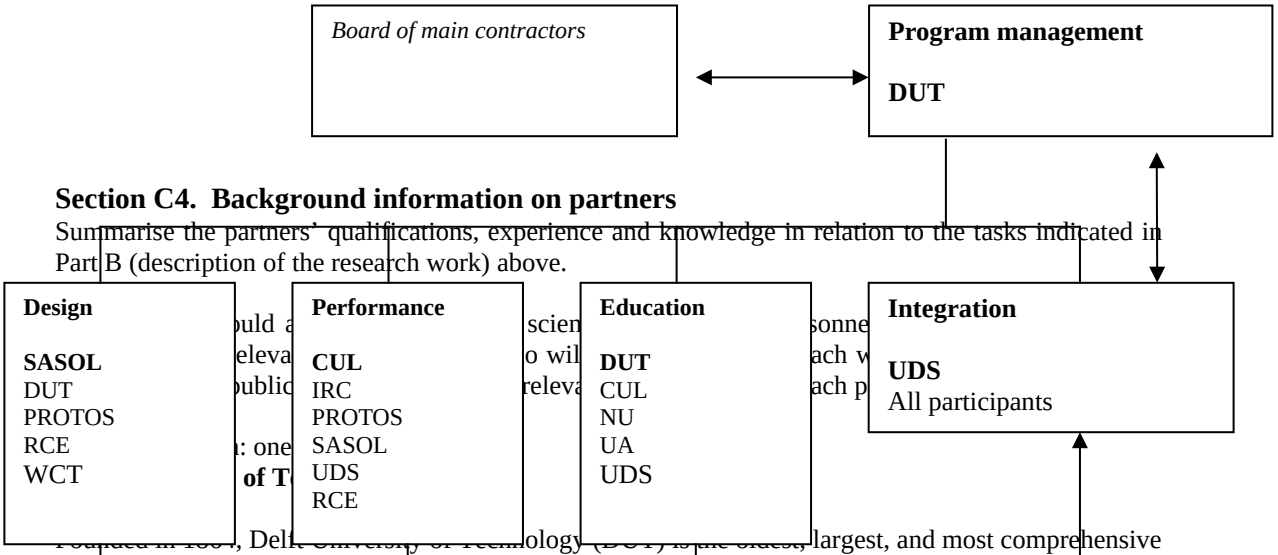
These four fields constitute the workpackages (a,b,c specific, and d overall), together with a project management package.

	Participant	*Country*	*Knowledge*	*Position*
1	**Delft University of Technology**	Netherlands	Design issues Education	University
2	**IRC**	Netherlands	Water use performance Health	Research insitute
3	**Amsterdam University**	Netherlands	Education Sustainability issues	University
4	**Catholic University of Leuven**	Belgium	Agriculture and hydrology Education	University
5	**Protos**	Belgium	Water development projects	NGO
6	**SASOL**	Kenya	Design issues Water development	NGO
7	**Nairobi University**	Kenya	Water use performance Education	University
8	**Westerveld Conservation Trust**	Kenya/the Netherlands	Design issues	NGO
9	**Roda Coffee Estate**	Tanzania	Rural development	NGO
10	**University of Dar es Salaam**	Tanzania	Resource management Education	University

The contracting structure



The work structure



Section C4. Background information on partners

Summarise the partners' qualifications, experience and knowledge in relation to the tasks indicated in Part B (description of the research work) above.

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ounded in 1864, Delft University of Technology (DUT) is the oldest, largest, and most comprehensive technical university in the Netherlands. With over 13,000 students and 2,100 scientists (including 200 professors), it is an establishment of both national importance and significant international standing. The University collaborates with other educational establishments and research institutes, both in the Netherlands and overseas. It also enjoys partnerships with governments, branch organisations, numerous consultancies, the industry, and companies from the small and medium business sectors. TU Delft wants to continue focussing on combining its own strengths, building more partnerships, and participating in both nationally and internationally-recognised research programmes, committed to answering to increasingly multifaceted demands, to benefit people in the future.

CICAT

CICAT is the central liaison office of DUT providing its faculties and departments with management support in the field of development co-operation activities. The activities implicate long lasting co-operation projects with universities and research organisations in Africa, Asia and Latin-America and to some extend in Easter Europe. CICAT is commissioned by the University Board of DUT to stimulate international co-operation at the faculties and departments of DUT. The aim of the projects should be to strengthen the education and research of the university or research institute involved. Simultaneously CICAT locates relevant expertise in Delft, when asked to do so by organisations from outside the university, to work on development co-operation projects. CICAT is responsible for the management and co-ordination of the projects, while the faculty or department involved is responsible for the scientific content of the project. CICAT is active in the support of education at DUT in three different ways. The first refers to DUT students willing to undertake a graduation project abroad. The second is the organisation of special courses at the Delft University of Technology and the third is the organisation within projects of PhD work at the DUT or within a so-called sandwich formula.

Civil Engineering Project Education

The Department of Civil Engineering at Delft University of Technology is unique in the Netherlands. Its principal teaching and research areas deal with the design, the construction and the maintenance of complex systems of infrastructure. Within the educational program, Civil Engineering Project Education organizes about 125 projects each year. Each project group has about student 8 members that spent four to six weeks during the year in the project, depending upon the year in which the project is carried out. In project groups students analyze a problem and design a solution for it. Learning goals are the gathering and elaboration of information, the application and integration of knowledge in a concrete situation, working in a group, oral and written presentation of results and learning how to analyze a problem in order to solve it. During the project many relevant aspects have to be taken into account, both social and technical, as in real practice. All these analyses are to be used to elaborate upon a technically and socially acceptable solution. In project education students have to apply the

knowledge they already have acquired in a systematic way. In daily practice, this means that they try to apply a number of methodologies that have been introduced in the lectures of other courses. Process-oriented and technical tutoring is provided by staff-members. Each project group has to write a report, which will be available to fellow students, supervising staff-members and institutions involved.

Land and Water Management

The Land and Water Management group is part of the department of Civil Engineering and Geosciences. Its' education and scientific research is concentrated on the planning, design, construction and operation of water management systems, including the organisational aspects. Areas of special interest are:

- Design of water management and distribution systems such as polders, irrigation/drainage systems, flood control systems and urban water management.
- Maintenance planning and budgeting of water management systems
- Design of operation strategies and control algorithms for controlled water systems.
- Integrated water management with the accent on policy-analysis and the decision methods for developments in water management, considering the legal and institutional environment.
- River Basin Management

DUT Personnel

Theresia Twickler
CICAT

Maurits W. Ertsen
Land and Water Management/Civil Engineering Project Education
Irrigation engineer

Key qualifications

- Professional experience: 7 years
- Present position:
  - coordinator of civil engineering project education
  - PhD-research at Land and Water Management

  Main research interests and specializations:
  - water management,
  - integration of social and technical aspects,
  - education and training,
  - participation of users in technological development,
  - design issues,
  - history of technology

Relevant publications (selection)

Ertsen M.W. 2000 Integrated learning in engineering studies. The potential role of project education. Sixth Interamerican Conference on Engineering and Technology Education, Cincinatti, Ohio, USA, 14-16 June 2000

Ertsen M.W. 1999 The technical and the social in engineering education. Design and the social sciences. Making connections. Alberta, Canada

Ertsen M.W. 1999 Sustainable water use in the Proyecto Rio Dulce. Why history matters to modern irrigation. International Symposium on Irrigation, Drainage and Flood Control, Bratislava, Slovakia

Ertsen M.W. en T. Heijer 1998 A systems approach to sustainability in water issues. 1st inter-regional conference on environment-water: innovative issues in irrigation and drainage, Lisbon, Portugal

Ertsen M.W. 1997 Supplemental irrigation in the Proyecto Río Dulce, Argentina. How farmers make use of available rainfall. Workshop International Commission on Irrigation and Drainage, Oxford, England

Section C5. Project management

Please describe how the proposed project will be managed, the decision-making structures to be applied and the communication flow within the consortium.

Communication

The responsibility for the communication between the partners is embedded in two ways:

The project management package includes this issue, as the consortium will open a web-page open for the general audience and a discussion-list for its members. Each year all participants will meet during a workshop of a few days, discussing progress of the specific workpackages in the context of the general package Research and development. Each half year the board participants will have a meeting to arrange project related issues.

The three specific workpackages Design, Performance and Education will establish communication between the partners involved, partially through the project-broad communication facilities, partly through own media. Each package will have a responsible institution.

The Research and Development package is coordinated by the Project coordinator.

Please list and cost the items of durable equipment to be purchased by the project, the total sum corresponding to the figure provided in Form A4.
Maximum length: two pages.

Section C6. Environmental Impact and Ethical Considerations

Identify and quantify any potential non-targeted social, environmental and economic impacts of the proposed project, and explain what measures will be taken to minimise the risk of any harmful impacts. Particular attention should be paid to bio-safety aspects of work involving genetically modified organisms, stating where appropriate how the work conforms to national or international legislation.
Identify the need for ethical clearance for experiments involving human subjects and/or animals.
For short-listed proposals, ethical clearance documents will have to be provided before a contract can be signed. Moreover, ethical practices and problems will have to be reported on during execution of the work.
Maximum length: one page.

Section C7. Economic development and scientific and technological prospects

Please describe in concrete terms the plans for the dissemination and/or exploitation of the results for the consortium as a whole and for the individual participants.
Maximum length: one page.

Section C8. Ongoing projects, previous and related proposals

- If the same or a substantially overlapping application has been or is being submitted to any other Community, national or international programme(s), give details of how the proposals relate to each other in terms of technical content and partners and give the results of any previous evaluation.
- If you are aware of any proposals being submitted by other groups under this Call with which you see a potential for synergy or actual collaboration, please give details of same (title, co-ordinator and thematic sectors).

Section C9. Cost Summary

Please annex to part C a copy of page A4 (2 parts) “Cost Summary”.