APPENDICES

Advisory review of the
environmental impact statement
Andhra Pradesh groundwater
bore well irrigation schemes (APWell)
and
recommendations for the Inception Report
of the APWell project, India

(appendices 1 to 8)

APPENDIX 1

Letter of DGIS dated 6 April 1995, in which the Commission has been asked to submit an advisory review

Ministry of Foreign Affairs

The Hague

Commissie voor de milieu-effectrapportage
t.a.v. de heer drs. J.J. Scholten
Postbus 2345
3500 GH Utrecht
Nederland

Directorate-General
International Cooperation

Date : 6 April 1995

Re : Review EIA APWELL/India
WW/92/850
JRC 381-93;
MER/94/009

Ref : DST/ML
93/1995

During 1993/94 an Environmental Impact Statement (EIS) has been prepared for the Andhra Pradesh Ground Water Bore Well Irrigation Schemes project (APWELL) in India. In July 1994 the project was approved by the Minister for Development Cooperation. At that time it was decided to ask the Commission for Environmental Impact Assessment to review the Environmental Impact Statement (EIS) in detail during the inception phase with the aim to include the results of the review and recommendations in the reception report. The project will start the 1st of April 1995 with an inception phase, for a period of five months. In this phase a management information system (MIS) a.o. will be set up and a workplan for the next two years will be elaborated. The inception report will be available in September 1995.

Therefore I would like to ask the Commission to set up a working group to draw up an advisory report on the review of the EIS, based on:

* the EIS and the background documents sent to you (see annex 1);
* the preliminary discussion on 30 March 1995 between E. van Lent (DAL/ZZ), L. Verbeek (DST/ML), D. de Zeeuw en A. Kolhoff (Commission for EIA).

For the review framework use can be made of:

* the Terms of Reference of the EIS in Annex 4 of the APMIS projectdocument;
* the checklist of the Asian development Bank regarding irrigation projects;
* the checklist for irrigation project prepared by the Government of India;

* the sustainability concept as defined in the Netherlands policy document "World of Difference".

Furthermore, I invite recommendations of the Commission concerning:

1. the execution of the project focusing on:
   - criteria for site selection;
   - irrigation design alternatives with a view to the conservation of ground water resources and the potential problem of salinity;
   - institutional aspects of water management, including water users participation;
   - health aspects;
   - social (gender) aspects as far as relevant to the environmental aspects of sustainable development;
   - monitoring and evaluation.
2. the strenghtening of the Indian EIA potential in the field of capacity building in futurem with reference to your experiences in reviewing the APWELL-EIS.

With regard to the gender aspects I refer to the gender impact study executed for APWELL in 1993.

In view of the wide scope of the impacts it is recommended to include the following main disciplines in the working group: (geo)hydrology, irrigation (agriculture), rural sociology (gender), institutional aspects/(water)management and health. In coordination with the Royal Netherlands Embassy in New delhi the Commission will have to visit the location. In accordance with the normal procedure, you are requested to ensure consultation and participation of the various Indian interest groups as much as possible.

With reference to the EIA agreement between DGIS and the Commission, I would appreciate receiving information concerning membership of the working group and the budget for the aforementioned advisory report.

THE MINISTER FOR DEVELOPMENT COOPERATION
For the Minister
Head Environment Programme

K.A. Koekkoek

Annex 1

Documentation APWELL

* DGIS & APSIDC; Andhra Pradesh Ground water minor well irrigation schemes (APMIS). Project document, March 1992.
* ASCI; Environmental Impact Assessment APMIS & APLIFT, project proposal, October 1992.
* DGIS & APSIDC; APWELL, projectdocument, January 1993.
* ASCI; EIS, APWELL, main report and annexures, April 1994.
* Delft Hydraulics; Assistance to Environmental Impact Assessment in APWELL and APLIFT, June 1994.
* Euroconsult; APWELL project, India, Technical proposal, November 1994.
* Euroconsult: Annex 7, Environmental Issues APWELL project, of revised financial proposal, January 1995.

APPENDIX 2

Project information

Proposed Activity: The government of India intends to construct 5400 groundwater bore well irrigation schemes covering a total net area of 16,200 ha in seven districts in Andhra Pradesh, India. The government of the Netherlands has been requested to provide funding for this initiative. Main objective of the project is to increase agricultural production of small and marginal farmers in the project area through the provision of groundwater facilities. The long term objective is to improve the living conditions of the small and marginal farmers in the project area. This will be achieved through sustainable interventions, in such a way that both men and women can obtain equal conditions and opportunities in agricultural and other activities.

Project numbers: WW/92/850; JRC 381-93; MER/94/009; Cie m.e.r. 011

Progress: An EIA was executed in 1994. The project was approved by the Minister in July 1994 and started the 1th of April 1995 with an inception phase, for a period of five months. In a letter dated 6 April 1995 the Minister for Development Cooperation in the Netherlands has invited the Commission for EIA in the Netherlands to review the EIS and formulate recommendations with the aim to include these in the inception report. A review advice has been submitted to the Netherlands Minister for Development Cooperation on 14 July 1995. The inception report will be available in September 1994.

Composition of the working group of the Commission for EIA:
Mrs Prabha Mahale
Mr K.K. Bhattarchayya
Mr R. Kuiper
Mr A. Meijerink
Mr D. de Zeeuw (chairman)

Mrs V. Groverman and Mr W.B. Snellen have participated as resource persons.

Technical secretary: Mr A.J. Kolhoff.

APPENDIX 3

Working programme mission
Andhra Pradesh groundwater bore well
irrigation schemes, India

Tuesday 6 June	22.20 hrs.	Arrival Dutch members of the Mission (Mr D. de Zeeuw, Mr A. Meijerink and Mr A. Kolhoff) with KLM in Delhi.
Wednesday 7 June	09.00 hrs.	Briefing at the Royal Netherlands Embassy with Mr P.J. Kuperus, Head of the Development Cooperation Section and Ms Mona Sharan, Programme Assistant, Land and Water.
	11.00 hrs.	Meeting with Mrs N. Bhat of the Ministry of Environment and Forests.
	13.30 hrs.	Meeting with Mr Rajendra Mishra, Deputy Secretary, Ministry of Water Resources.
	16.40 hrs.	Departure to Hyderabad.
	18.40 hrs.	Arrival in Hyderabad.
Thursday 8 June	09.00 hrs.	Meeting with Mr Satish formerly working with Administrative Staff College of India (ASCI).
	11.00 hrs.	Meeting with Mr Murali Khrisna, Managing Director and Vice-chairman of IDC.
	11.10 hrs.	Arrival of fourth Dutch member of Mission, Mr R. Kuiper with British Airways in Delhi.
	12.00 hrs.	Meeting with Mr Babu Rao, Director of Groundwater Department in AP.
	12.40 hrs.	Meeting with Mr Bhattacharya, Secretary of Irrigation, Department of Irrigation & Command Area Development.
	13.00 hrs.	Meeting with members APWell project team: Mr C. Isles; Mr Capt. M.S. Dillon IN; Mrs V.R. Pineda; Mrs J.Jairath and Mr C.S. Rao.
	14.15 hrs.	Meeting with Mr T.L. Shenkar, Director of ASCI.
	15.30 hrs.	Meeting with Mr R.S. Rao, Director of APRSAC.
	16.40 hrs.	Departure Mr R. Kuiper from Delhi to Hyderabad.
	18.40 hrs.	Arrival Mr R. Kuiper in Hyderabad.

Friday 9 - Monday 12 June **FIELD VISIT**

Persons who joined the working group during the field visit:
- Mr Chalamaiah (working with APSIDC)
- Mr C.S. Rao (working with IRDAS)
- Mr Capt. M.S. Dhillon IN (APWell project)
- Mr B. van Lavieren (APWell project/Euronconsult)

Friday 9 June	07.30 hrs.	Pick up at Gateway Hotel. Visit bore wells in Mahbubnagar district: · Farooqnagar bore well in Mr P. Pentaiah's field · Raikar 64 bore well in Mr Y. Ramaiah's field · Bore well in Mr Jangaih's farm · Bore well in Mr V. Chenniah's farm · Bore well in Mr V. Thimaiah's farm Night halt at Nandyal.
Saturday 10 June		Visit bore wells in Kurnool district together with Mr K. Raju, District Collector of Kurnool: · Bore well in Peddatekua village · Bore well in Tammarajupalli village · Bore well in Sugalimetta village · Bore well in Yagantipalli village
	18.00 hrs.	Meeting with Mr Malla Reddy, Director of Accion Fraterna. Night halt at Anantapur.
Sunday 11 June		Visit bore wells and watersheds in Anantapur district with Mr Malla Reddy and Mr R. Sundar Vadan, Project Director Integrated Drought Relief and Resource Development Agency: · Atmakur Kudera watershed · Vanju Banka Watershed · Bore well at Muktapuram village · Gudduru/Vishaka watershed
	07.30 hrs.	Meeting with Mr Manmohan Singh, District Collector of Anantapur.
	17.00 hrs.	Meeting with Mr R. Sundar Vadan. Night halt in Anantapur.
Monday 12 June		Return journey to Hyderabad.

Tuesday 13 June		Writing of the advice.
	09.30 hrs.	Mr Uday Shankar, Director of AFPRO.
	11.00 hrs.	Meeting with Chair of APSIDC, Mr Murali Khrisna, Managing Director and Vice-chairman of IDC; Mr Chalamaiah, Chief engineer and Mr N.S. Jagannadha Rao, Executive engineer.
	12.00 hrs.	Meeting with Mr P.J. Shastri Retd. Director General Water and Land Management and Training Institute (Walamtari).
	18.00 hrs.	Meeting with Mr Shashi Kumar, Director of Thinksoft.
Wednesday 14 June		Writing of the advice.
	11.00 hrs.	Wrap-up session in the office of APSIDC. In consultation with Mr Samarajit Ray, Principle Secretary of irrigation; Mr Bhattacharya, Secretary of irrigation, Mr Sathyanarayana, Joint Secretary of irrigation; Mr Babu Rao, Director of Groundwater Department and the APWell project team.
	15.00 hrs	Meeting with Mr J. Hari Prasad, Mahila Samatha Society (Indo-Dutch programme for Women's empowerment through education).
	19.30 hrs.	Departure Mission from Hyderabad to Delhi.
	21.30 hrs.	Arrival at Delhi.
Thursday 15 June	09.00 hrs.	Debriefing at the Dutch embassy with Mr P.J. Kuperus and Ms Mona Sharan.
	10.00 hrs.	Meeting with Mr Jeurissen, Ambassador.
	10.30 hrs.	Meeting with Mrs N. Bhat at the Ministry of Environment and Forests.
Friday 16 June	00.30 hrs.	Departure Mr R. Kuiper from Delhi to Amsterdam with British Airways via London.
	00.50 hrs.	Departure rest of Dutch Mission from Delhi to Amsterdam with KLM.

APPENDIX 4

Review framework for the EIS Andhra Pradesh groundwater bore well irrigation schemes, India

Guidelines prepared by the Commission for EIA which are used to review the EIS as described in chapter 2.

Structure of this appendix **page**

1. INTRODUCTION

Problem analysis and project objectives
The EIS should contain:

- an analysis of the constraints for increasing agricultural production and improving the living conditions of the small and marginal farmers;
- the rationale of the project relative to the analysis of constraints;
- a definition of the objectives of the proposed activities to enable the identification and formulation of alternatives and to furnish criteria for monitoring and evaluation.

2. PROJECT SETTING

Policies and legislation
The EIS should describe National and State policies, laws, rules and regulations concerning the proposed project, i.e. in the field of water resources and (irrigated) agriculture.

Institutional setting
The EIS should:

- describe the institutional framework (organizations and institutions which are dealing with water resources and agriculture, in the governmental, non governmental and private sector) at the state and districts level and at mandal level as far as relevant, including competent authorities directly involved in the execution of the project and the control of the executed works; the interrelations between the different institutes should be indicated;
- indicate whether institutes and organizations involved in the project have capacities (in staff quantity and quality) and policies to deal adequately with environmental issues.

3. APPROACH OF THE STUDY AND SITE SELECTION

3.1 Approach of the study

Considering that the current framework of EIS review is drafted *after* the Project Document and the EIS itself was prepared, the execution of the EIS should at least fulfill the following three steps:

1. Decision on delineation of the project area
   A selection of the districts in which the project is to be carried out. This is a policy decision based on the projects objective to concentrate on small and marginal farmers. Criteria are the socioeconomic conditions of the districts, the availability of groundwater and the existing irrigation facilities. A practical criterium may be the desire to choose adjoining districts. Per district a rough estimation of the number of wells to be established should be made.

2. Potential locations for bore well clusters
   The project area is mapped based on small scale topographic maps of the Survey of India and divided into homogeneous regions in respect to geohydrology and groundwater, topography, ecology, socioeconomic conditions, agricultural conditions, available irrigation facilities and soil conservation. Based on these maps potential areas for the establishment of clusters are identified.

- In two potential areas a cluster should be selected. Criteria for selection are described in § 3.2. A detailed pilot EIS should be carried out for two clusters which are considered to be typical for the project area.
- A summary of all other promising potential areas should be presented in the EIS.
- In three other potential areas a cluster should be identified for which a rapid EIA will be prepared. A detailed methodology for a rapid EIA is to be developed in the framework of this study.

3. Site specific EIS
   Two detailed pilot EIAs should be elaborated. For each of the two selected cluster sites, control sites should be found in the same potential area. Each of the two pilot cluster-EIS sites are subject of detailed study, first the potential site where the bore wells will be installed and secondly the control site in which bore wells have been installed already several years ago. The control site will act as a reference to measure whether the (expected) project impacts are a result of bore well installation or from other developments (as well). The physical and socioeconomical conditions of prospected cluster site and control sites should be comparable.

The guidelines presented in chapters 4, 5, 6, 7 and 8 should be used for the preparation of the pilot EIAs.
The Commission recommends this approach since it holds the opinion that it is not possible and not useful to make a complete inventory of potential cluster sites for the entire project area within the scope of this study.

Considering the fact that the APWells project was already approved and the project is proceeding, the above three-step approach seems practical. Step 1 has already been taken. Step 2 has not been made, but is needed to arrive at a systematic way of identification of the most promising areas for bore well installation. Step 3 has partly been taken, since two detailed pilot EIAs have been prepared, but the question how to deal with the environmental impacts on other cluster areas still remains open.

A next step is the identification of individual bore well sites. However, actual bore well site selection is not within the framework of this study, also not on pilot basis. Concerning bore well site selection only the procedures and criteria for site selection are to be covered.

The procedure to be followed by farmers who are interested in the installation of a bore well(s) should be elaborated.

Sustainability[1]

To realize the long term objective of the project, which is mentioned in § 1.1, it is necessary to make clear in the EIS what is meant with sustainable and environmentally sound interventions and which will be the consequences for the project implementation. Therefore conditions for the selection of potential sites and conditions for the implementation of irrigation schemes (e.g. number of bore wells, location and design of schemes et cetera) should be defined for each cluster of bore wells, because the physical-, socioeconomic- and institutional conditions may differ per site.

3.2 Site selection for bore well clusters

The EIS should:

- Motivate the selection of the seven districts in AP where the project will operate and the distribution of the 5400 bore wells over these seven districts. Motivation may be in part socioeconomic and technical, but will be strongly guided by policy considerations, i.e. poverty alleviation. If so, this policy has to be explained.
- Motivate the concept of clustering bore wells.
- Provide the criteria to be applied for cluster selection. The items mentioned below are to be addressed and other items may be added where needed. The criteria and their numerical values are to be drawn up for each district separately.

Cluster selection criteria
The following items should be addressed when drafting selection criteria for clusters.
Criteria should be given and their importance ranked. Criteria mentioned are provisional: during the course of the project criteria and values of criteria may have to be adapted when experience is gained.

Size command area

- minimum command area which should be available;
- contiguousness of bore well commands.

Physical conditions

- groundwater availability (to check if the minimum number of bore wells can be installed); current exploitation according to the classification of the Department of Groundwater per Mandal ("white, grey or black"), minimum discharge per tube well allowed, availability of the minimum allowable discharge within an acceptable drilling depth (30-80 meters), long-term equilibrium between withdrawal and recharge, local effects on the groundwater level;

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[1] To define sustainability the Commission recommends to make use of the following definitions:

- Sustainable land use development can be defined as the development of land use systems that meet the needs of the present populations without causing environmental degradation and consequent loss of ecosystem production potential in such a way that these land use systems can be maintained with the means of these populations determined by the limitations of their socio-economic environment. This definition can be split up into:
- Ecological sustainability implies that land is used in such a way that production levels (output) can be maintained for actual and future populations, without causing environmental degradation and consequent loss of ecosystem production potential.
- Socio-cultural sustainability of an activity (e.g. use of land) means that such an activity can continue to be carried out and supported by a specific target group by their own means and within the limitations set by their socio-economic environment, also when outside support from development organisations has ceased or been limited to an important extent (so without an everlasting subsidized external input).
- Economic sustainability is defined as the maximum flow of income that could be generated while at least maintaining the stock of assets (capital) which yield these benefits.

- groundwater quality: occurrence of saline groundwater, fluoride content;
- wells: number of wells per subcatchment, success rate of well drilling in the area;
- topography: maximum allowable slopes, allowable land levelling requirements;
- hydrological condition: drainage condition (percolation of the subsoil, natural drainage channels), incidence of waterlogging and flooding, minimum depth of post-monsoon groundwater level;
- soil: rockiness, soil texture, occurrence of usar (sodic soils), soil salinity.

Infrastructure and facilities available
- allowable distance of the cluster to the 11 KV electricity grid;
- power availability in the area (i) yearly mean, in hours per day (ii) during critical cropping periods, particularly in Rabi;
- available spare capacity of the sub-station covering the prospected cluster;
- distance to the nearest urban area;
- distance of the area from metalled roads and availability and quality of unmetalled roads to and in the cluster area;
- presence of other sources of irrigation supply, notably public canal systems and tank systems;
- availability of maps, particularly air photos, topo sheets 1:50.000 and chadar sheets 16" to the mile.

Socioeconomic conditions
- percentage small and marginal farmers of the total number of interested farmers;
- percentage of the land to be irrigated owned by small and marginal farmers;
- percentage female headed households of the total number of interested farmers;
- percentage scheduled castes and scheduled tribes of the total number of interested farmers[2];
- ownership of the lands to be irrigated;
- economic dependence on agriculture;
- cultivation of the land to be irrigated by the landowners.

Particular conditions
- experience of the local people with watershed management;
- possibilities of artificial recharge in the area;
- willingness of the local population to join in such a programme;
- on-going land consolidation programmes;
- possible joint operations with other projects/programmes, e.g. erosion control, salinity control.

[2] Female headed households, small and marginal farmers et cetera, have to defined clearly.

4. DEVELOPMENT OF ALTERNATIVES AND MITIGATING MEASURES

4.1 Development of alternatives (physical planning of a cluster of bore wells)

If a potential site/village for the installation of a cluster of bore wells is selected the following procedure should be applied:

1. The number of bore wells to be constructed should be motivated in the context of sustainable use of groundwater. Sustainable use of groundwater is a precondition which limit the scope of the intended activity and means extraction may not exceed (natural) recharge and no irreversible change in quality may occur.

2. The needs of the beneficiary farmers (categorized into socioeconomic groups) should be inventoried. Special attention should be given to womens needs.

3. Based on the needs, alternatives (e.g. location, design, construction, maintenance and management) for one cluster of bore wells/irrigation schemes should be worked out, together with the beneficiary farmers who are fully participating in this process.

   For a sustainable use of the irrigated land/land use, conditions should be defined. These conditions limit the scope of the alternatives to be elaborated. The selection and delineation of the individual bore within a cluster should allow for considerations on physical and social aspects (selection criteria for bore wells per cluster):

   Physical aspects
   - water availability (to define the maximum number of bore wells);
   - average size of holdings;
   - the fields in the command area should be adjoining;
   - crossings with metalled roads;
   - local topography and soil conditions, local risks of erosion, salinization;
   - other sources of irrigation supply (canals, tanks, other bore wells) and the reliability of irrigation supply;
   - minimum distance of the well to another well;
   - minimum distance to other wells to avoid possible local impact;
     - nearby domestic water supply hand pumps. India Mark II (withdrawing at 30 – 35 meters) and traditional pumps (reaching to 6 – 8 meters);
     - open wells;
     - shallow (8 – 10 meters) boreholes with diesel sets for irrigation purposes;
     - private electric tube wells (depth approximately).

   Socioeconomic aspects
   - minimum number of landowners;
   - presence of landowners, i.e. not living abroad or in other parts of the country;
   - the maximum percentage of the total command area owned by one landowner;
   - willingness of the landowners to cooperate with each other and the project;
   - willingness to declare the bore well site to be communal land;
   - willingness to contribute a percentage of the construction costs; this percentage is to be predetermined by the project;
   - willingness to participate in formal and informal water users association/farmers cooperative/any other suitable legal entity which ensures the users group a legal basis;
   - willingness to ensure adequate O&M after handing over of the well by APSIDC to the farmers group.

Alternatives

In this section ideas will be presented for the development of alternatives. The opportunities for development of alternatives are set by the (pre)conditons.

- Location;
  - an inventory should be made of possible locations of bore wells and irrigated fields.
- Design and construction;
- Management (operation & maintenance);
  - crops grown and size of irrigation area
  - methods of surface irrigation
  - sectoral water (quantity) management
  - integrated water management at cluster village and watershed level
  - methods improving the efficiency of water use
  - control of pests and diseases
- Other
  - in the project document is stated that the bore wells will be supplied by public electricity. What are the possibilities for other forms of (sustainable) energy supply, e.g. diesel sets or solar energy?
  - infiltration (artificial recharge) improving measures like e.g. terracing, check dams, contour bunding at field level, cluster and watershed level.

4. The alternatives have to be discussed in a workshop within and between the distinguished beneficiary socioeconomic groups (separately for men and women). To overcome potential conflicts about the use of resources, it is important that non-beneficiary villagers are represented at the workshops.

4.2 Mitigating measures

The EIS should describe mitigating measures to prevent or reduce negative environmental impacts in which both socioeconomic and institutional aspects are considered to ensure that the project activities benefit the target group, men as well as women. Moreover, mitigating measures should be described to prevent or reduce negative effects on non-beneficiaries. Existing knowledge systems and techniques used by men and women should be considered, for example in the field of water and soil conservation.

Mitigating measures to prevent or reduce negative environmental effects of the project should be described.

5. DESCRIPTION OF THE ENVIRONMENT, AUTONOMOUS DEVELOPMENT AND IMPACTS

Prevailing condition of the environment
The prevailing condition of the environment (with environment is meant, the natural and socioeconomic environment) in the study area (current situation) should be described as far as relevant for the forecasting of the impacts of the intended activity or alternatives. This means that the existing environmental condition in the study area should be described for aspects as mentioned in this chapter. The study area is not fixed and differs for the various impacts.

Autonomous development
The development of the environment of the study area should be described in case the intended activity will not be executed. The information about the autonomous development of the environment is important to get clear what the contribution of the irrigation schemes will be in relation to the expected future development. The agricultural development and broader changes in use and management of natural resources should be described to understand better possible developments in irrigated agriculture due to project activities. Different effects of changes and trends for women and men should be indicated.

Impacts of the intended activity and its alternatives
The way impacts are described and measured should be motivated. Expected impacts can be predicted by making use of the occurred developments at the control sites. It should be noticed how far impacts are irreversible, temporarily or permanent and in how far cumulation occurs. Negative as well as positive impacts and direct and indirect (induced) impacts should be described.

The Commission asks attention for the following aspects. All the aspects are mentioned once and if relevant they should be described for the current situation, the autonomous development and for the impacts.

c = the current situation / prevailing condition of the environment
a = the autonomous development
i = impacts of the intended activities and its alternatives
. = means no description asked for

5.1 Physical environment

Describe:
c/./. • The geology and morphology of the study area.
c/a/i • The water balance of the village(s), watershed (if possible) where the cluster of bore wells is situated.
c/a/i • The availability via shallow wells, bore wells et cetera and suitability of groundwater for domestic and agricultural purposes.
c/a/. • The soil conditions.
c/a/i • The quality of the soil, surface- and groundwater.
c/a/i • Ecosystems and their characteristic flora and fauna, identification of vulnerable ecosystems, environmentally valuable areas and protected areas (dehydration).

5.2 Socioeconomic environment

Describe:

c/a/i • Demographic situation; total population, density, growth, pressure on land, migration, differentiated according to caste, ethnic group and gender, percentage of female-headed households (de facto, de jure) per district, mandal and of the villages where the selected potential sites are located.

c/a/i • Major types of activities, of men and women, in the village.

c/a/i • Socioeconomic groups in the villages in terms of landownership and main source of income (own land, agricultural labour, migration, formal/informal employment et cetera); indicate whether the majority are men or women.

c/a/i • Land use patterns (presented in maps), indicating the area and which socioeconomic groups men/women make use of the natural resources.

c/a/i • The use of the natural resources (renewable and non-renewable) regarding the relation between exploitation level and carrying capacity. This can be defined as one of under-exploitation, equilibrium or over-exploitation.

c/a/i • Agricultural situation; crops, indicating whether certain crops are gender-related, cropping patterns, production, subsistence-cash orientation. HYV-low external input orientation, application of water and soil conservation techniques, livestock.

Health, describe:

c/a/i • Health situation and facilities: availability of safe drinking water, treatment and discharge of sewage, occurrence of water born diseases in particular: *malaria, filariasis* and *Japanese encephalitis*.

c/./. • Health hazards associated with the project based on health records at district, mandal and village level.

./a/i • Health risks including the following considerations:
- community vulnerability; identify socioeconomic groups within the community to be affected by the project and assess the nature, magnitude and likelihood of exposure; estimate the prevalence rate of each hazard from health records and/or a special survey;
- environmental factors; consider the environmental factors and their magnitude that may contribute to a change of health risk;
- capability of protection agencies; establish the capabilities of existing protection agencies, such as the environmental and health agencies;
- change in food intake and food habits.

5.3 Institutional environment

Describe:

c/a/i • Informal and formal organizations of men and women in the village having control over natural resources such as water, land, forest et cetera.

c/a/i • Availability of facilities/infrastructure: roads, transport, power, market, agricultural inputs (shops), extension, education, services and supporting NGOs/GOs.

6. COMPARISON OF THE IMPACTS OF THE INTENDED ACTIVITY AND ITS ALTERNATIVES

A comparison should be made for every pilot EIA between the expected impact of developed alternatives of the potential site with the existing situation (eventually including autonomous development). To control the expected impacts use should be made of control sites where bore wells and schemes are installed several years ago.

7. REMAINING GAPS IN KNOWLEDGE AND, MONITORING AND EVALUATION

A monitoring plan should be developed in order to be able to compare the predicted impact with the actually occurring impact. It should be investigated whether the actual; environmental impacts are more positive/more serious or less positive/less serious than the predicted environmental impact and whether future measures should be taken. It should be clear which organisations are capable to execute the monitoring. The following parameters are important to monitor:

Groundwater quantity and quality
- groundwater levels;
- well capacities;
- salinity;
- fluoride content;
- nitrate content.

Soil
- input-output analyses (seeds, fertilizer, pesticides, labour et cetera versus yields and revenue);
- assessment of the types and areas of crops grown;
- the irrigated area;
- the waterlogged area;
- area affected by salinization;
- irrigation efficiency.

Socioeconomic aspects (to be differentiated according to socioeconomic groups and gender):
- access to and control over water from bore well;
- access to and control over O&M of the bore well;
- access to and use of safe drinking water;
- changes in income;
- changes in crops cultivated;
- changes in cropping patterns;
- changes in land use activities;
- changes in access to irrigated land;
- access to and use of extension and other services from the project (NGO/GO);
- extent of women and men migrating from and to the villages;
- changes in women's workload;
- changes in gender division of labour;
- formation and existence of women groups/organisations;
- nutritional state of women and children.

Public health
- use of pesticides and impacts on health;
- occurrence of (water borne) diseases (malaria, diarrhoea et cetera);
- (infant) child mortality rate.

Biotic environment (as far as relevant)

- occurrence pests and diseases;
- availability of forest products (fuel et cetera).

8. REPRESENTATIVENESS OF THE PILOT EIA STUDIES

A comparison should be made between the impacts of all pilot studies. It should become clear at which aspects/impacts they are comparable and differentiate, and how this can be explained.

APPENDIX 5.1

Observations in support of the recommendations

This appendix consists of:
- information to underline the recommendations as presented in chapter 3;
- recommendations of lower order than the ones presented in chapter 3;
- technical remarks and examples of sustainable agricultural practices, on request of the APWell project team in Hyderabad.

Structure of this appendix **Page**

1. SITE SELECTION

1.1 Criteria and procedures of cluster site selection

The selection of suitable sites for groundwater development is based on the 1:50.000 geomorphological maps, which is a joint product of 1:50.000 topographic maps and the interpretation of remote sensing images. The preliminary conclusions are checked during field visits on the inventory of open wells and bore wells, and by the observation of geological features.

The Commission advises to focus on areas where no or little groundwater development has been done so far. Because there are no opportunities for installation of a cluster of bore wells in areas/ watersheds were there is a situation of equilibrium (withdrawal = recharge) or overexploitation (withdrawal > recharge) of groundwater.

As already stated before, groundwater availability, possibilities for artificial recharge and socioeconomic conditions should be the main criteria for cluster selection. However, other elements should be considered as well, like:

- electricity position, i.e. distance of the cluster to power lines, its location along that line, estimated power availability in the area (annual mean – in hours per day – and during critical cropping periods), available spare capacity of the sub-station covering the prospected cluster;
- topography, i.e. maximum slopes, land levelling requirements;
- soil, i.e. rockiness, soil texture, occurrence of usar (sodic soils), soil salinity;
- roads, i.e. distance of the area from metalled roads and availability and quality of unmetalled roads to and in the cluster area;
- other sources of irrigation supply, notably public canal systems and tank systems.

1.2 Clustering of bore wells

The bore wells are proposed to be clustered, the amount of bore wells in one cluster depending upon local conditions, such as: availability of groundwater suitable locations, interest of farmers, availability of electricity and other relevant factors. APSIDC has experience with clustering and the Commission supports this approach for a number of reasons:

- electricity supply is easier and less costly arranged; better arrangements can be made with APSEB in case of bore well clustering than in case bore wells are scattered;
- agricultural and water management extension will be more effective in view of the limited staff resources of the involved departments and the project;
- clustering coincides well with measures for recharge and watershed management;
- practical project implementation considerations.

2. IMPLEMENTATION AT SITE LEVEL

2.1 Physical environment

2.1.1 Present availability of groundwater

From an environmental point of view, the developments point clearly to a non-sustained use of the groundwater resources in large parts of the cultivated area of the districts in the study area. The declining water levels and yields of most of the bore wells, associated with reduced yields indicate the magnitude of the problem. It is evident that the withdrawal exceeds the natural recharge and that mining of the water resource takes place.

The assumed recharge rates (without proper watershed management) in the project documents are on the optimistic side and are not based on actual field studies in the various hydrogeologic regions of the project area. These field studies should consider the wells as located in 'hydrotopes', i.e. natural associations of geomorphology, lithology, soils and land cover/parcel characteristics of micro-catchments in order to asses the recharge. It may be expected that the recharge rates without watershed management are in the order of 5 – 15 per cent of the annual rainfall, depending on local conditions and temporal rainfall distribution. Examples of the variability of some 'hydrotopes' in the project area are given in appendix 5.2.

The situation of some 30 years ago, when irrigation was practised from open, shallow, hand dug wells, may well reflect a sustained use, in which withdrawal equalled the natural recharge. Studies using old aerial photographs have demonstrated that the irrigated areas generally varied from 1.2 to 3.85 hectares per well in the various hydrotopes ("landscapes" in the table of figure 5 of appendix 5.2). Except in 'productive' hydrotopes, such as those found on the Vempalli Dolomites and marls, the irrigated areas were not contiguous over large areas and generally were surrounded by recharge areas of appreciable size (see appendix 5.2). In the Vempalli rock zone the open wells had a depth of 4 to 6 meters; the first boreholes have been drilled till some 45 meters, irrigating about 2.5 hectares, while now drilling till 80 or 90 meters occurs (with a – as yet – exceptional depth of 200 meters). The limited depths of the traditional open wells prevented overdrafts during low rainfall years, when – of course – decreased crop yields occurred.

The above figures may be considered as the lower limit of the sizes irrigated areas, because with bore wells a larger part of the saturated zone can be used, hence the buffering capacity (or carry-over effect) improves. Furthermore, properly sited bore-wells will have relatively high yields and thus larger recharge areas, reducing the costs of operation per unit of irrigated area. However, only a marginal increase of the irrigated acreage under sustained use should be expected unless proper studies will prove otherwise, particularly in view of the effects of water conservation in the recharge areas, which are poorly known as yet. It is difficult to estimate what the size of the irrigated area per well will be on a sustained basis. This will depend on the effectiveness of watershed management, apart from the large spatial variations, due to geomorphology, lithology and rainfall. Some examples of the latter are given in appendix 5.2.

There are still many areas in the project districts with an under-utilization of groundwater, and where development could occur in a sustained manner. The knowledge of identifying such areas and the evaluation of the hydrotopes is present (APRSAC/APSIDC/AP Groundwater Department/ Regional Centre CGWB). It can be expected that most of such areas will have well yields below the averaged yield of all wells quoted in the documents pertaining to the APWell project. It should be remembered that the quoted averaged yields pertain to a non-sustainable situation.

The project documents do not mention the presence of certain zones in the Cuddapah Basin, where important well yields can be expected, such as along the Gani-Kalawa fundamental fault zone, the Rudravaram zone or the downdip part of the Paniam quartzites below Nandyal shales et cetera (see geological map, appendix 8). Geophysics and detailed field investigations are required for well location, and care should be taken not to affect the discharges of the existing springs and the water level of the coconut groves.

The present pattern of groundwater development may well reflect roughly the availability of water at the time of drilling. The areas to be selected by the project may be less promising from a groundwater point of view, and they may be remote from services and electricity but such areas generally have poorer farmers. In order to ascertain a sustainable groundwater use, a flexible approach towards the target of 3 hectares may be adopted. Some of the potential areas are near the forests and due care should be taken that the forest lands are not affected.

All these considerations should be included in the Master Plans (see chapter 3). However, it is believed that for the Master Plan there is yet insufficient knowledge concerning the actual areas under irrigation and the drafts, the amount and the availability in time of the surface water, as well as the recharge with its spatial variations. Studies of these aspects should precede the formulation of the plan.

The estimates for recharge made in the project documents are based on crude guidelines and are not supported by proper studies in the project districts itself. Moreover, the figures pertain to rock type only, while it is known that in hard rock terrain, the geomorphology, rainfall distribution and land cover may overshadow the effects of rock properties.

2.1.2 **Future availability of groundwater**

The Commission finds that the present development of groundwater exploration in the project area by the private sector will lead to an increased lowering of the groundwater levels. The agricultural production will receive an impetus because of the mining of groundwater, but this will be short-lived. Hence, after the 'mining-period', the area irrigated by groundwater will reduce and lifting costs will increase. Without interference the future scenario (over 10 to 15 years) will be characterized by a stronger competition for deeper bore wells at the expense of the small and marginal farmers and a reduced irrigated acreage at a higher operational cost on a district basis.

There is no reason to assume that the decline of the water levels will reduce without interference. The decline is in the range of a few meters to 25 meters (or even more in a few cases) over the last decade or less. The – estimated – annual increase of some 15.000 to 20.000 wells by the private sector in Anantapur district, for example, is a cause of great concern. The recharge effects of an exceptional wet year are likely to be depleted soon, because the aquifers in the project area do not have much storage.

It can be expected that the rate of decline will accelerate in the near future in large parts, because of:

- at lower depths the water storage is less in hard rock country, due to decreasing specific yields with depth;
- a competition for deeper wells will start or continue, with more powerful pumps, specially by the economically strong farmers and it needs little explanation what this means for the poorer segment of the farming community.

The initiatives for watershed management implementation are encouraging. It will lead to increased agricultural production by itself and it has a side effect on the groundwater levels. However, the latter effects should not be overestimated on an a-priori basis. For example in the Vanju Banka watershed management scheme, (Anantapur District) the irrigated area increased 4 times, while the number of wells increased by 3.3 times, but the period of observation is short. Other studies in similar terrain suggest the level of improvement to be at least of the same order of magnitude, but in favourable – localized – cases, up to doubling the discharge rates has been noted (in case of groundwater discharge areas, fed by sloping alluvial areas with sandy layers in valley bottoms and substantial – semi confined – lateral flow from permeable weathered/fractured rocks).

The assessment of the true recharge in the various hydrotopes is crucial to the sustainable use of the groundwater. For these reasons, the monitoring and analysis functions are emphasized. The results also form an important component for the District Water Master Plan.

Estimation of pumped amounts of water
Data will be needed on pumped amounts of water within micro catchment areas in order to assess withdrawal versus recharge. However, within and outside APSIDC no records are available on pumped amounts of water per bore well. The number of pumping hours is unknown. Also no reliable data on well discharges is known: the initial discharge was measured during the pumping tests, either or not with a compressor. Current discharges are not measured and can only be estimated.

Dependable estimates of pumped amounts per season of water may be obtained using bore well data on irrigable command, crops grown, areas per crop and soil type. A methodology for such estimations should be developed and calibrated using data on lift irrigation schemes, since in such schemes data on pumping hours and discharges are usually available. This means that the estimations based on cropping data can be matched with the existing records.

2.2 Socioeconomic environment

2.2.1 **Farmers participation**

A systematic effort must be made to design a gender-specific strategy which actually addresses gender issues at various stages of the scheme implementation and ensures effective participation of small and marginal farmers (including women). Some of the elements of such a strategy are:
Initial stage:

- collection of gender-specific base-line information using the approach and methodology of Gender Assessment Study;
- rapport with village panchayat, existing farmers/women's organizations;
- identification of female headed households;
- dissemination of information of irrigation scheme and loan facilities;
- formation of informal bore well water users groups, mixed/women exclusive groups/Watershed Association/Watershed Committees;
- selection of NGOs with expertise in gender, watershed development and sustainable (irrigated) agricultural practices;
- training/gender awareness of male/female staff of APSIDC and NGOs.

Construction stage:

- access to credit facilities;
- use of farmers/women's organizations for recruitment of labour;
- development of agricultural extension packages taking into account men's and women's preferences for crops;

- training in sustainable agricultural practices/training in decision making and leadership qualities/facilitating access to other government programmes like crop loan, horticulture, sericulture, Integrated Pest Management (IPM) et cetera.

Initial operation stage:
- training of male and female farmers in management of water scheme and O&M.

2.2.2 **Farmer's (women's) needs**

During the field visit, the following concerns of small and marginal farm households were observed which need special attention for the implementation of bore wells and irrigation schemes:

- Women and men priorities and preferences should be promoted in the project area. The recommended cropping patterns, apart from providing food security to the small and marginal farm family, should also provide women's needs for fodder and fuel.
- Access to drinking water in summer is a problem reported by women in most of the villages. Therefore, needs for drinking water should be taken into account when designing irrigation schemes. Further, while selecting physical locations of the bore wells, special care should be taken to see that the already scarce drinking water source in the catchment area is not adversely affected.
- Women have reported increased workload while working on their family farm. There are more crops to be looked after, and higher yields bring more post-harvest activities. The cultivation of vegetables in particular means much more work for women. This workload is shared by the adolescent girl child and has negative impact on her discontinuing education. Further, there is a widening gap between male and female roles in the agricultural production system resulting into a loss of control for women. (Men go to towns to arrange for loans, inputs, marketing and receive agricultural extension training and service.) It is recommended to carefully monitor these negative impacts and evolve a remedial strategy to overcome them.
- A positive impact of irrigated agricultural practice is increased income. However, it should not be assumed that increased income automatically leads to increased well being of all family members. For a number of qualitative indicators to measure the improvements in living conditions, see § 3.5.
- The project focuses on privatisation of bore well schemes and requires farmers to contribute 10 – 20 per cent of the construction costs of the scheme. Small and marginal farm households with outstanding debts and household primarily run by women face restraints in having access to bank loans. NGOs and institutions involved in farmers organizations should reach them by providing information on loan facilities that could be practically accessible to them.
- It is observed that the cash position of small and marginal farm households temporarily deteriorates because there is a shift from wage labour to unpaid labour on the own farm. Women are the first to make this shift. Therefore it should be considered to develop a simple and accessible system of consumer credit, especially targeted to women.
- Families benefitting from irrigation have reported increased family income in the first three years but later, due to reduced water yields, there is a drop in the family income and women are forced to take to paid labour to supplement the family income.
- Lower wages are paid to women in spite of the government legislation directing payment of equal remuneration for equal work. APSIDC should set a trend by paying equal wages to men and women contributing labour in construction stage and in watershed development programme, women's groups could be given a group contract.

2.2.3 **Land ownership**

Access to irrigation is related to ownership of land. Most land property is in the name of men and inherited by them. But there are differences in inheritance patterns between caste communities e.g. among Kammas and Reddys, women at the time of marriage receive a small landholding in their name. Female headed households like those of widows, with young children or in the absence of a male, have land holdings in their name. It is recommended that special attention is paid to these inheritance patterns in the base-line surveys, for that would be helpful in identifying women beneficiaries.

The APWell project document has stipulated that in case of government assigned land, the title of the land shall be given in the name of the women. This is in line with the AP government's order issued in 1984 that pattas for government assigned agricultural lands shall be given in the name of women (see appendix 6). During field visits it was observed that men have continued to receive pattas of government assigned land in their name even after 1984. According to the Principal Secretary Irrigation (AP), these land titles in the name of men are illegal and the District Collectors should transfer them to women's name without payment of registration fees. Since women's ownership is a selection criterion, APWell should assist the local NGO in transferring the ownership of government assigned land to women.

30 per cent of the targeted households are managed by women. These women do not own the land but are practically the managers and cultivators of their farms mainly due to high male migration. Within the context of male migration, female headed households should get priority in the selection criteria.

The project aims at creating equal partnership for men and women. Therefore, it is recommended that farm households which have men and women's joint ownership of land are to be given priority next to the female headed households.

2.2.4 **Irrigation efficiency**

The degree of land levelling or land grading varies considerably per bore well scheme, as does the effectiveness of bunding. Obviously, poor land levelling/grading and wide spacing of bunds (or none at all) affects the application efficiency of irrigation greatly. In addition, land levelling and bunding also enhances the effectivity of rainfall, both for direct crop use and for recharge of groundwater. APSIDC assists these activities, but does not provide subsidies. Since land levelling involves relatively high costs, considering the income position of small and marginal farmers, a contribution of the project to land levelling is expected to increase interest among farmers.

A second way of improving irrigation efficiency, is to line the distribution channels. The water saving effect of such a measure will be relatively high, particularly in coarse textured soils, but is normally less than improving land levelling or field bunding. It should be implemented supplementary to the former mentioned measures.

Increase of conveyance efficiency may be achieved by the application of lining, e.g. a small plastered masonry channel, but also by the application of a subsurface pvc pipe. Such a pipe would be provided with an outlet for each farmer. Advantages of a pvc pipe are the high efficiency of conveyance, almost 100 per cent if properly installed, no loss of land and no maintenance required if installed well. Further, the application of a subsurface pipe enables crossing minor depressions in the terrain and installing the bore well on another location than the highest point of the command area without having to construct an elevated embankment. However, the application of subsurface pvc pipes also has distinct disadvantages, as has become clear in the DGIS assisted Indo Dutch Tube well Project

in Uttar Pradesh. In case the construction of the subsurface pvc pipe line is poor, which may frequently occur, the pipe leaks and worse, is choked with soil. Repair of leakages and choked sections and the repair of broken off-takes are more difficult than repair of masonry channels, which can be done by any local mason or the farmers themselves. Also pre-cast concrete flumes are sometimes applied, but they are vulnerable and cannot be repaired by the beneficiaries or local craftsmen. Precast flumes are not considered for APWell project. APSIDC is in favour of the application of pvc subsurface pipe lines. Further, APSIDC reports that pvc pipe lines are already applied and that the system performs well. Still, the Commission has reservations because of earlier experiences.

Possibly the best solution is to explain advantages and disadvantages to the concerned farmers and leave the choice to them. In any case, the project should make provisions to have the construction of underground lines supervised thoroughly. Further, the performance should be monitored closely.

2.2.5 Technical irrigation aspects

Irrigation methods
Irrigation methods observed were basin/level border irrigation, graded border and furrow irrigation and wild flooding. Interestingly, also here and there trickle irrigation was observed, practised by progressive farmers, apparently having some funds available. Trickle irrigation is rapidly spreading since the 50 per cent subsidy on investment by the government of Andhra Pradesh is not only applicable to small and marginal farmers, but to every farmer. Since trickle irrigation is basically the most suitable irrigation method to deal with – expensive and scarce – bore well water, the project could identify bore well locations on the additional criterium that trickle irrigation will be applied.

Bore well command area
Each bore well will have its own water distribution system. Only in exceptional cases command areas should be formed which join the yields of two or more APWell bore wells.

Type of bore wells
Apart from the standard (6" or more) boreholes with an electrical submergible pump, as anticipated in the project documentation, other solutions may be feasible if groundwater conditions allow:
- in-well, small diameter boreholes provided with a diesel pumpset;
- diesel pumpset in case of shallow groundwater.

Choice of power, electricity versus diesel.
Although the reliability of electric power supply by the grid is not high, the option of powering the submergible pumps by a diesel generator is obviously not attractive for the farmers. Reportedly, the cost of electricity from the grid is about Rs. 500/acre.crop and the cost of a diesel genset would amount to about Rs. 1200/acre.crop. Another problem associated with diesel generator sets is that proper maintenance is not assured. Still, it would be advisable to look further into the possibilities of power generation by diesel, since it would give the beneficiaries more control over their irrigation timings, thus reducing risks.

The application of diesel pumpsets in bore wells is usually not possible due to the depth of groundwater.

2.2.6 Sustainable agriculture

Crops and cropped area
It was observed that part of the command area of many bore wells is used for paddy cultivation and part for irrigated dry cash crops, such as vegetables and groundnuts. The average yield per well and command area per bore well as foreseen in the project document is too high to ensure sustainable

use of water resources. Moreover, a substantial part of the irrigated area will be used for paddy cultivation, which reduces the potential command area even further. Depending on whether or not adequate recharge measures are taken, an average irrigated area per well in Rabi should not be more than about 2 and 1.2 hectares respectively. In Kharif, when irrigation is supplementary to rainfall, a larger irrigated area may be possible. It will be necessary to look into the irrigable areas per bore well scheme again once the strategy on water withdrawal is formulated.

In order to reduce water consumption, it could be considered to design for crops in Kharif only. However, this will hardly be a realistic option in practice, and this option should not be pursued.

Sustainable agricultural practices
Sustainable (irrigated) agricultural practices should be applied to guarantee the productivity of the land, the health situation of the farmers and to avoid soil erosion and pollution of soil and groundwater in the long term. A number of practical examples of these practices are given:

- Enhancing maximum possible close and cyclic nutrient flow pattern.
  A nutrient balance should be made and the possible input and output of nutrients from the system should become clear and balanced. In these efforts of balancing special care should be given to harness the locally available knowledge and materials like:
  - Reducing runoff/erodability of soil (by land levelling, contour bunding, lining, contour ploughing et cetera as mentioned in § 2.2.4.
  - Desilting and using the deposits back into the field (which is being practised in a few watersheds visited).
  - Proper use of crops and animal residues and excreta through composting (preparation and handling of which was observed to be poor).
  - Controlled grazing.
  - Use of green (leaf) manuring and bio-fertilizers and vermicomposting (composting by worms, which is very uncommon).
  - Use of (leguminous) trees for pumping nutrients and trapping nitrogen from the air against volatilization loss (very rare). In fact the agro-forestry cropping system may be very useful in these areas. The population density and planting geometry of the tree species should be carefully designed such that the tree covers do not become aggressively suppressive to the annual crops. This requires location specific participatory technology development involving farmers and scientists of regional research stations where NGOs and GOs can play a facilitating role.
  - Integrated Pest Management (IPM). The drier parts of Andhra Pradesh stand first in the world as far as the acreage of groundnut is concerned. Most of the high yielding varieties because of their common parentage have a very narrow genetic base and stands a high risk of devastating damage and sometimes total crop failure in the event of any outbreak of pest or disease. Currently expertise on IPM techniques for cotton, groundnut, paddy, brinjals et cetera have been standardized and are readily available. For these techniques, Central Plant Protection Institute and International Crop Research Institute for Semi Arid Tropics at Hyderabad, Tamil Nadu Agricultural University at Coimbatore, Biological Pest Control unit of University of Agriculture Sciences at Bangalore and Peoples Patriotic Society foundation at Madras may be contacted. One example; bollworm in cotton can be fought by: spraying with an extraction of cotton kernel; virus infected larvae can be crushed in to organic solvent; which can be diluted for spraying and neem based pesticide.
  - Use of synthetic chemicals should really be the last resort as a supplement to the above mentioned methods.

- Moisture conservation by biomass cover. Vegetative cover is an important means to conserve soil moisture by lowering soil temperature. In semi arid tropical areas during summer season soil mulch (live or dead) is capable of reducing soil temperature by 8 to 10 degrees Celsius at a depth of 5 to 10 cm compared to ambient situations. It was noticed that under some fruit trees groundnut shells were being used as mulch. Large scale application may be limited due to the usage as fuel supplement (as indicated by one farmer in Anantapur). The use of groundnut shells as alternative sources of fuel should be studied. An alternative measure for moisture conservation is may be growing of Redgram and Groundnut as Ally cropping. Redgram which stands erect and sends roots to a deeper layer may be planted on ridges (if necessary to avoid water stagnation) within the irrigated groundnut. Redgram will reduce the wind velocity thereby conserving the moisture by reducing the desiccating power of the wind. Within the soil, roots which feed from different layers than groundnut, will pump escaped nutrients and bring them back on the soil surface through leaf fall. Moreover, redgram stem is a good source of fuel. Similarly, location specific relays and multi-tier cropping can be designed in a participatory manner with the farmers. In this process the existing knowledge pool of International Crop Research Institute for Semi Arid Tropics, Central Research Institute on Dryland Agriculture and Andhra Pradesh Agricultural University may be utilized.

- Use and management of common lands. The farm size of small and marginal farmers (main beneficiary of the APWell project) may not be large enough to sustain in their livelihood (simple calculation shows that marginal farmers exert few folds more pressure on farm land). Therefore, reliance on other sources of income (off-farm employment, raising of animals et cetera) becomes unavoidable and hence pressure on the village common lands (grazing land and forests) are mounting. Big farmers and landless peoples are also involved in this process. This may result in overexploitation and degradation of common lands. Which leads to decrease of recharge due to increase of run off. Therefore, management of the use of common lands is extremely important and should be one of the components of watershed management. Integration of this component has been observed by the Commission in one of the watersheds visited. The following measures were executed or planned: reforestation, preparation of stone walls to protect reforested land from grazing and create opportunities for natural regeneration of vegetation, controlled rotational grazing, replacing goats (browsers) by sheep (grazers).

2.2.7 **Health aspects**

A shift from traditional varieties of crops to high yielding varieties, with an increased use of fertilisers and pesticides, have affected women's health. Common health problems reported are diarrhoea, back pain, anaemia, TB and malaria. The Gender Impact Study executed for APWell mentions that farm women consider the increasing reproductive health problems and cancer as related to the increased use of pesticides. Therefore, the use of pesticides and fertilizers and the experienced effects on health should be monitored.

2.3 Institutional environment

2.3.1 **Government policy**

Recently watershed management is adopted as an approach for rural development and various GOs and NGOs are currently active in this field. The DPAP adopted the watershed approach in 1987. The guidelines for Watershed management of the Ministry of Rural Development (1994) is a good example of this shift and provides an adequate framework for application. In practice, the great number of departments concerned in the implementation of programmes following this approach is felt as the most important constraint.

In Anantapur district GOs and NGOs work according to this approach in the execution of the Drought Prone Area Programme for a number of years and with success. Because the District collector of Anantapur stimulated and coordinated the cooperation between the various departments involved to make an integrated approach successful. In general the District collector has the opportunity to do so and therefore it is recommended to elaborate the integrated watershed management approach for each district.

2.3.2 **Recharge improving measures**

Improved groundwater recharge through watershed management protection should form an integral element in the APWell project. Since groundwater recharge is such a crucial element in the sustainability of the project, a stronger emphasis of the project on watershed management is recommended. There appear to be good prospects of securing links between the APWell project and DPAP watershed management and improvement programme. This programme is funded by the government of Andhra Pradesh (GoAP), and joint operations between APSIDC and DPAP has already been carried out. Also links with the UNDP watershed management programme in Mahbubnagar, Kurnool and Anantapur districts seem well possible.

The Commission's visited, the DPAP funded watershed programmes in Tammarajupalli village in Kurnool District, and the Atmakur Kudera watershed, the Vanju Banka watershed and the Gudduru/ Vishaka watershed in Anantapur District. The programmes' physical protection works included checkdams for improved recharge, gully and plugging by rockfill dam, contour bunding including outlets and stone fencing. Further activities comprise reforestation and natural regeneration of vegetation.

Notwithstanding the general sound design and good quality of works, a few remarks may be made:
- infiltration checkdams were not always chosen in the correct locations;
- rockfill dams controlling gulleys and nalas were sometimes too widely spaced;
- spillways capacities are often too low with the risk of lateral erosion;
- the line between two subsequent spillways of contour bunds was unprotected and erosion of crop land may result due to concentrated flow during high intensity rainfall;
- influence of check dams in rivers on groundwater recharge is overrated in certain locations.

2.3.3 **Water users groups**

The number of beneficiaries per scheme will be 4 or 5 at most. Therefore, it does not seem very useful to establish formally registered farmer cooperatives in the bore well schemes. On the other hand, intensive support of the water users groups by (NGO) extension teams, is needed to assist the farmers with a variety of issues, e.g. bore well maintenance, land levelling, field channel construction and drainage provisions if relevant, water distribution, choice of crops and crop husbandry. Further, the beneficiary groups have to be supported in their relations with "outside" GOs, such as APSIDC, APSEB, District authorities and DPAP. The problem of informality can be solved to include representatives of the water users groups of the APWell bore wells in the Watershed Committee.

The Watershed Committee is responsible for the set up and execution of a watershed development plan. In the ongoing watershed protection programmes of DPAP and UNDP, Watershed Committees are formed per micro catchment. A further possibility may be the formation of a formal Water Users Association or farmers cooperative on cluster level, although the individual members of such an organisation would not draw from the same water source. Such an organisation would enhance the institutional position of the beneficiaries considerably, particularly if no watershed protection programme is ongoing and no watershed committee exists. Non-beneficiaries should be represented in

the watershed Committee because usually they make use of the common lands. These lands are needed for preparation of technical works to improve the recharge and for e.g. reforestation. For successful watershed management these lands should be part of the tasks of the committee.

APWell should investigate legal and social aspects of formal and informal water users groups. The practical aspects should be an important point of deliberation, taking into account the tedious formal procedures of cooperative formation and the input of the project required.

In case of government assigned land, wherever possible, exclusive women water users groups should be formed. Experience from government project like Development of Women and Children in Rural Areas (DWACRA), Andhra Pradesh Training of Women in Agriculture (ANTWA), Trift and saving Groups of Women and Mahila Samatha have proved that women's participation is more effective in women's exclusive groups than when they participate in mixed groups of men and women.

In the Watersheds visited, (Atmakur Kuderu watershed, Vanju Banka watershed and Guddura/ Vishaka watershed), the representation of small and marginal farmers in the Watershed Association (at micro watershed level) and Watershed Committees (at village watershed level) was very low as compared to big farmers, while that of the landless agriculture labourers and women was totally absent. Women's participation in the watershed was limited to paid labour in contour bunding, construction of checkdams, percolation tanks and in raising government nurseries. Women from marginal farm households at Guddura/Vishaka watershed expressed that they had to tread long distances for collecting fuel wood and fodder as the nearby hillocks were cordoned off for pasture development and afforestation purposes under the watershed development.

To enable female farmers to voice their concerns and to allow them an active role in decision making processes and to participate in non-stereotype roles, their participation should be ensured in the over-all analysis, planning and decision making regarding the development of the watershed and the bore wells. Their training should be organized by the NGOs.

2.3.4 **The quality of electricity supply**

- The quality of electricity supply concerns the duration (daily average per season, fluctuations in daily supply, incidence and duration of grid breakdowns), single phase and fluctuation of voltage.
- Supply is particularly unreliable during the period March to May/June. Supply is 8 hours/day on a (rough) annual average, but with wide seasonal and daily variations. Also the supply varies widely per location. Strong fluctuations of voltage and single phase occur, often resulting in burning of the motor of the pump.
- The occurrence of single phase is in theory prevented by the Single Phase Preventer (SPP) in the bore wells' switch board. However, this device is of poor quality and frequently fails. As a result after breakdown the SPP is often not replaced but bypassed.
- Reportedly, the SPP version currently installed is more reliable than the older versions. Another possibility is the installation of a Mini Circuit Breaker (MCB), which automatically switches the pump off after a heavy voltage deviation. This device is more reliable and hence provides better protection to the motor. Prices do not differ substantially. Disadvantage is that the switch has to be returned to the original setting by hand. If this happens to be necessary quite often, the switch may be secured in its operating position (by a match) by the farmers, thus reducing its usefulness to zero. Nevertheless, the installation of MCBs over SPPs is preferred in APWell, since an MCB is more reliable than the SPP and can be controlled by the farmers.
- The quality of the constituting parts of the electric equipment in APSIDC bore wells is sometimes poor. Although quality materials are intended to be used for installation, sub-standard equipment is sometimes delivered and installed. It is imperative for the successful O&M of the bore well by

farmers that the quality of the electrical equipment and its installation is optimal. Special care should be given by the project to this point.

- Before finally deciding on the location of a cluster of bore wells, discussions should be held with APSEB, in order to assess the future electricity condition in that area. It should become clear whether or not sufficient spare load is still available at the substation, on the rural feeder and the 440-KV lines. If not, which measures are possible to alleviate the power situation. If no firm commitment of APSEB can be obtained on timely connection (say within 3 months after application by APSIDC), a regular and reliable power supply (say, at least 8 hours a day on an average) to the cluster of bore wells, the cluster should not be developed. Particular care should be practised in case the cluster is at the end of an 11-KV rural feeder or a 440-V line. Promises to extend the line should be checked on their viability.

2.3.5 **Bore well maintenance**

The responsibility for maintenance of the bore well, including both pumpset and electrical appliances, was so far with APSIDC, but is increasingly handed over to the bore wells' beneficiaries. The start of this process of transfer is of recent date, and both farmers and the department will have to find their ways within this new situation. This may result in a decline, at least temporary, in the technical maintenance situation of the bore wells. In this transition phase – in which the government agencies hand over maintenance responsibilities to the users and the users still tend to rely on government for maintenance – a particular attention to the proper organisation of maintenance of the bore wells is needed.

It should be realized that for the users the acceptance of responsibility for maintenance may increase costs: in case APSIDC maintains the bore well the farmers pay a water rate of Rs. 200/season.crop and a government subsidy of Rs. 300/acre.crop is provided through APSIDC. If no maintenance is provided by APSIDC, no water fee is paid. Although the total maintenance costs may be lower than Rs. 500, it is certain to be more than the current contribution by the farmers. This will be a threshold for farmers to assume responsibility for maintenance.

2.3.6 **Training and extension**

- The water users of the bore wells visited have received no training in water sharing, maintenance and operation of the bore well. In all the bore wells visited the water availability has reduced over a period of three to four years and farmers wanted APSIDCs' intervention in redefining the catchment area to be irrigated under the depleted source of available water. In some other cases, a new power structure had emerged where one farmer with better access to information and government service had started exploiting water users of his group.
- Out of the eleven bore wells visited, farmers of ten bore wells were not covered by agriculture extension. They lacked knowledge of suitable cropping pattern, water and soil conservation techniques and measures to be adopted.
- Extension services should be provided through a well-coordinated multi – disciplinary team as in the case of watershed teams in Anantapur district.
- The field staff of the NGOs should be trained in sustainable agriculture and irrigated agricultural practices. Assistance could be provided by the Dutch assisted project Agriculture, Man and Ecology at Bangalore.

2.3.7 **Institutional linkages**

- NAP should coordinate activities with other organizations operating in the same area to enhance the project's positive impact and reduce any negative side effects.

- Institutional linkages that are particularly relevant from a gender perspective are: Mahila Samatha (women's empowerment through education), ANTWA, APRWSS (Andhra Pradesh Rural Water Supply and Sanitation), UNDPs Watershed development project in Mahbubnagar.
- In Kurnool, Prakasam, Nalgonda and Anantapur districts under the Netherlands' assisted project Training of Women in Agriculture, village based training in agricultural techniques and institutional training in specialised, agriculture related activities are given to farm women. The Directors of the Farmers Training Centres of these districts should be approached to train and prepare an agricultural extension package for the farm women of APWell.
- In the Makthal and Utkur mandals of Mahbubnagar district, UNDP is supporting watershed development through women's group formed under the Mahila Samatha project. In this connection Mahila Samatha had organized a trainers' training workshop on issues related to watershed development. The APWell project team should take help of the resource persons of Mahila Samatha in training and enhancing farm women's participation in watershed development in its target districts.
- In Mahbubnagar district Mahila Samatha, a programme for education for women's equality has successfully organized women's groups around the felt needs. Institutional collaboration should be worked out in this district between the APSIDC, Mahila Samatha and NGOs.

2.3.8 **Institutional capacities and roles expected of implementing organizations**

- The institutional capacities and roles expected of implementing organizations assume importance in giving gender focus to the project.
- The NGOs are responsible for agriculture extension. Most of the local NGOs are specialized in village community work and are good at mobilizing and organizing the rural poor. But they lack adequate agricultural expertise such as agricultural extension and sustainable land use and the skill to integrate gender concerns. The commission has the impression that the project draws too heavily on the existing capacities of the NGOs.
- Within the given time frame and with the limited capacities of the NGOs in gender and land use practices, it seems unrealistic to aim for effective participation and proper representation of small and marginal farmers in general and for women in particular.
- APSIDC has a limited mandate to deal with gender concerns. The NAP with a full time gender expert, is expected to play an important role in strengthening the gender focus of the project. NGOs play a crucial role in this project in mobilizing and organizing the farmers, in agricultural extension and in training various partners. However, no specific task is allocated to them for taking care of women's component. Therefore, a sound institutional framework with clear responsibilities needs to be worked out for smooth collaboration between APSIDC, the NGOs and NAP. APWell should make a careful assessment of NGOs existing training capacities and of needs for strengthening of such capacities.
- The role of NGOs is very important in identifying and ensuring farm women's participation in the project. Therefore, NGOs should recruit female field staff and train them in the context of this programme.
- Rather than inviting two large NGOs to play an initiating role, it should be considered to involve a broader group of NGOs from an early stage. As they work closely with the farmers at the grass root level they will be more effective in mobilizing the target group.

3. MONITORING AND EVALUATION

The monitoring and evaluation component is crucial in the project and it is recommended that this component should be strengthened, more than is foreseen in the project document. A Management Information System (MIS) is required, of which the data bases with the data base management system, and Geographical Information System (GIS) coupled to the use of RS are main components.

3.1 Data base

1. Observation wells should be selected from the existing records, checked for consistency and made digitally accessible. The effort to compile a consistent data base should not be underestimated, and requires hydrogeological expertise, not mere keyboard entry of analogue data.

2. The institutions dealing with groundwater should establish compatibility of the data structures and the file structures of their data basis.

3. In the design of the geohydrologic data base attention must be paid to the close linkage with socioeconomic data. This linkage and an easy manageable data base are more important than a sophisticated geohydrological data base. A common relational data base management system for the entire data base may be a good choice.

4. As soon as possible a map on 1:250.000 scale of the hydrotopes must be prepared by involving APRSAC. To this map, to be entered in a GIS, the checked observation well data has to be entered, and a design of the observation network can be made. It is likely that some data is redundant, but that no data exists for certain hydrotopes, which should be remedied.

5. At least one observation well in a valley position and one in an upland position per hydrotope is required for the representation of the toposequence. Considering the large spatial variation in the granitic terrain and the large size of certain hydrotopes, it is advisable to adjust the number of observation wells. However, it is better to have a limited number of wells with good data than a large number of wells with questionable data.

3.2 Analysis and evaluations

Apart from the normal hydrogeologic standard operations, quantitative assessment techniques using GIS should be developed for the specific hard rock regions. Some standard procedures may not be valid. For example, it is not valid to interpolate water levels on either side of the large rock outcrops as there is in such case no contiguity of the water bearing rocks. Water budgets made this way will be erroneous. A proper segmentation of the terrain (hydrotopes et cetera) should be made for the water budgets. In certain hydrotopes, both on the granites and in some of the formations of the Cuddapah Basin, the groundwater is contiguous and forms a coherent body, in others it does not.

3.3 Recharge studies

The hydrotope map forms the first segmentation level, to be followed by selected smaller catchments within a hydrotope for elaborating the water budgets.

The recharge conditions vary widely and use should be made of aerospace imagery, in conjunction with field data. An example of a recharge study using imagery and GIS procedures for the granitic terrain in NW Orissa, is given by Joseph (1992).

It is advisable to determine the irrigated areas by using aerial photography, possibly high resolution satellite imagery. Electricity consumption could also be used for the approximation of the draft. The obtained data should be linked to the information mentioned in § 3.1. If the method of fluctuation/ specific yield can be used for a recharge estimate, the specific yield should be determined preferably for the various zones in the regolith and upper fractured zone.

There are a few springs (e.g. near Banganapalle draining the quartzites on the plateau) with known sizes of recharge areas. The spring discharge over the recharge area will provide a recharge rate. No such calculations seem to have been undertaken.

It may be useful to check old discharge records of smaller catchments for assessing the water budget during former semi-sustained conditions, by separation of base flow, delayed flow through tanks and direct runoff. This could provide the minimum recharge rates.

Estimation of the actual evapotranspiration may employ cover data from satellites. It is imperative that the cover densities/classes are based on groundthruth and not on spectral information only. Monitoring of changes in the cover type and density using sequential remote sensing can only be done by local calibration against non-changed surfaces (they should appear identical on the multi-temporal imagery). No Normalised Difference Vegetation Index values can be used in a direct manner, as has been done. The changes in the sizes of the irrigated areas, together with the rainfall data and the groundwater levels, are of course key elements in estimating the recharge.

It is possible to use the geophysical resistivity method also for the recharge studies, if applied on a micro-scale and calibrated against soil moisture levels in the profile (Becht 1995).

3.4 Training and implementation

The training should emphasize the water budget studies and the monitoring, which includes the digital data base development, coupled to remotely sensed data. The training component should be strengthened in order to achieve the planning and monitoring function, required for a sustained use of the groundwater.
There is adequate know-how on the use of RS for hydrogeology available with APRSAC in Hyderabad and with the NRSA as well as with the IIRS training institute in Dehra Dun. The training in water budgets/GIS is as yet not sufficiently strong at the latter Institutes, although a staff member with groundwater specialization is at present being trained in GIS at Institutional Training Centre, Enschede (ITC) in the Netherlands. Apart from the technical assistance (TA) executing the project, it is recommended that the training in these subjects should have a direct applicability by including an on-the-job training component and/or working with data from the project. Assistance may be obtained from staff of the CGWB trained under the WAMATRA project in Data Bases, Groundwater Modelling and GIS/RS, as well as by making use of the new possibilities of the Netherlands Fellowship Programme (part financing by Netherlands Fellowship Programme (NFP), part by project).

3.5 Socioeconomic aspects

It is recommended to develop a number of qualitative indicators to measure the improvements in living conditions. Some indicators are:

Workload and division of labour:
- Gender division of labour in productive, reproductive and community work (daily and seasonal) in terms of working hours, physical demands and importance for family welfare.
- The extent to which men and women take over from each other, in times of hardship and work pressure or because certain activities have become more profitable.
- The extent to which men or women are culturally excluded from any tasks and possible changes.

Family allocation patterns:
The extent to which changes in farming have affected:
- food habits and consumption patterns;
- nutritional status of women and children;
- the situation of girl children (school drop-outs, household and agriculture tasks);
- selection of cropping pattern;
- women's access to and control over agricultural produce and income, productive resources, food and health;
- access to institutions and services.

Women's self-image

Health:
- use of pesticides and impacts on health;
- occurrence of (water borne) diseases;
- (infant) child mortality rate.

3.6 Bore well irrigation

The comprehensive monitoring of all bore well schemes is preferable. If this is difficult to achieve in practice, the programme should include continuous monitoring of a few, say two, bore wells per cluster. The following items should be recorded:
- daily pumping hours;
- daily electricity availability in hours;
- grid electricity system breakdowns, duration and cause;
- breakdowns of pump and electric equipment under management of the water users group;
- bore well discharges, once per season;
- net irrigated area per season, crops and area per crop;
- performance of the underground pvc pipe line, if installed.

Further, per bore well scheme monitoring of
- use of herbicides, pesticides and fertilizers should be practised;
- qualitative judgements on changes in soil condition should be made up seasonally. This would include sodicity, salinity, erosion.

3.7 Watershed management

Depending still on the degree of involvement of APWell in recharge and watershed management, monitoring should in any case include the functioning of the watershed management projects of DPAP and UNDP as far as they are relevant for the recharge of APWell's clusters. Items to be recorded are rainfall, including rainfall intensity, continuous discharge measurements of the main drain of the micro watershed concerned, seasonal inspection of the condition of control structures in the watershed.

The implementation of such a monitoring programme should be done under the responsibility of APSIDC, which also should process the data. The actual data recording should be done by local people, trained and paid for by the project. It will be necessary to instruct them well and provide regular guidance in their work. This guidance could best be provided by a locally active NGO.

3.8 Institutional linkages

For the hydrogeologic analysis and monitoring, it is necessary to pool the resources and available know-how/experience of various institutions:

- Andhra Pradesh Remote Sensing Application Centre;
- Regional Office Central Groundwater Board;
- Small Scale Irrigation/APSIDC;
- Andhra Pradesh Groundwater Department;
- NGOs working in watershed management.

APPENDIX 5.2

Illustration of the spatial variation of hydrogeology and irrigation potential in the APWell project districts

Influence of recharge zone
The influence of the recharge conditions on the pattern of the former (1960's) irrigated areas by open, hand dug wells, corresponding to a sustained groundwater use, is shown in figure 1. (Meijerink, 1974). The white areas are the pediments (gently sloping surfaces on little weathered rocks, no alluvium), which are suitable for retention of runoff (watershed management). Note the relationship between the width of the pediment, i.e. recharge zone, and the width of the irrigated area (dots are wells).

Example of site selection
Two well clusters (open wells) are shown in the north east corner of the Eshwarakupan Dome area (Prakasam district), showing the local geomorphology and the recharge conditions for two well fields. At the lower part of the alluvial fans with shallow thickness of deposits, boreholes could be located, if water retention is practised on the fans to increase the recharge (Meijerink, 1974).

Hydrogeologic complexity
The block diagram of figure 3 shows a small part of the western Cuddapah Basin; the sequence Vempalli limestones, Tadpatri shales (hog-backs) overlain by near horizontal quartzite- marl formations (Meijerink et al. 1984).
Deep groundwater is gradually developed in the Vempalli limestones (competition for deeper drilling has started). Because of local karst (solution) recharge by tanks may need special approaches, which differ from those in the Tadpatri shales, because there water retention will have only local effect. Well yields in this formation are moderate. The overlaying formations act as main recharge areas (often forest lands) for a few natural springs and some boreholes have large yields, if located properly on the fractures.

Variation of surface water for recharge
Figures 4a and 4b show the areas irrigated as a function of the size of the drainage areas for two different parts on the granites and one metamorphic area. These could be taken as a measure of the amount of runoff available for recharge. The large differences between the areas may be noted, substantiating the need for differentiation of the project region into 'hydrotopes'.
Variation of irrigated area per well.
Variation of areas irrigated from traditional open wells during the 1960's with animal lifting power, reflecting sustained use of water are shown in the table of figure 5 (Meijerink 1974). The table reflects the large variation in the various 'landscapes' or hydrotopes. Part of the variation is due to differences in soil type (e.g. low conveyance and field losses in nos 16 – 18), part is due to well yields (e.g. sample nos 19 – 23 compared to nos 1 – 4).

Segmentation of the terrain (hydrotopes)
As has been remarked earlier, lithology forms only one component of the hydrotopes. A copy of a geological map of the Cuddapah Basin is included. Within each geological formation, a few hydrotopes exist, depending of geomorphology, cover and rainfall/evaporation. These can be delineated by using aerospace imagery. The same is true for the various terrain types of the Peninsular Granites and Gneisses and for the high grade metamorphic rocks along the eastern flanks of the Cuddapah Basin, where pediments dominate but locally thick fossil eolian sand covers exist (e.g. north of Yellaconda range).

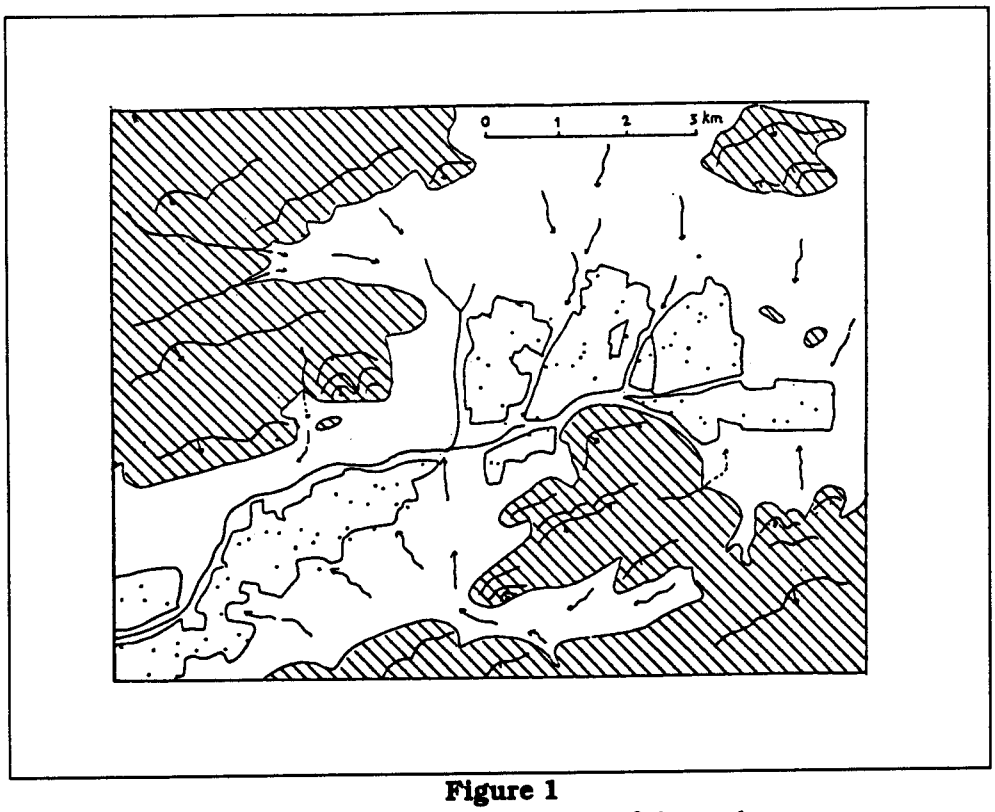


Figure 1
Irrigated area in relation to the width of the recharge area
(dots = open wells; white = pediments; hatches = hills)

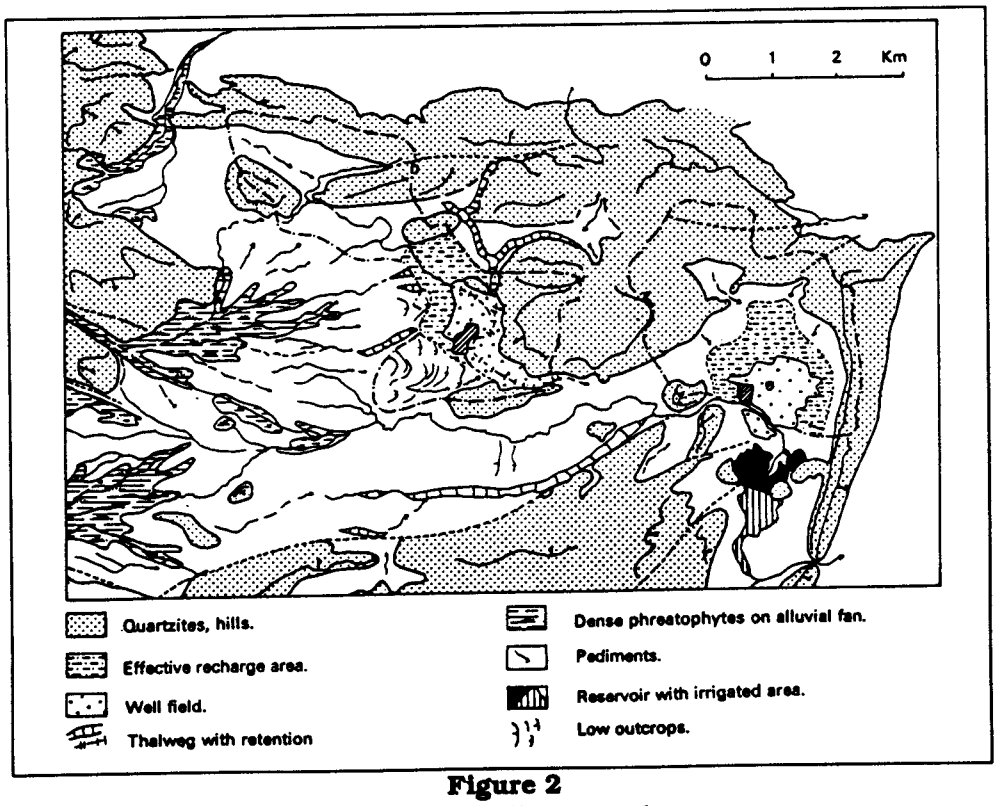


Figure 2
Location of well field, effective recharge areas
in area around Sunkusola.

SAMPLE AREAS, see notes below		2 No.of wells 2a well fields	2 No. of wells 2b individual sampled wells in clusters	3 Mean irrigated area per well		4 Estimate of standard variation s	5a judgment photogr. field and crop response (see text)	5b judgment field (see text)
Principal geomorphological unit or geomorphological unit	Individual sample areas Geomorphological sub-unit or land element			of 2a hect.	of 2b hect.			
Landscape on eastern metamorphic complex	1. lower pediment slope along river biotite schists (?)	50	22	1.33	1.51	0.62	+	0
pedimented area without sand-cover	2. Ibid *, sericites	25	9	1.75	1.71	0.93	+	0/+
	3. Ibid , gneisses	23	18	1.31	1.32	0.72	+	0
	4. Ibid , slates	32	17	1.63	1.46	0.52	0	+
Landscape on eastern metamorphic complex	5. lower pediment slope, thin to moderately thick sand cover	54	11	2.35	2.50	0.55	+	+
pedimented area with sand-cover.	6. pediment, thick sands	59	14	2.52	2.05	0.77	+	+
	7. lower pediment slope, reworked sands, moderately thick (?)	24	9	2.35	2.08	0.39	+	+
	8. Ibid	46	13	2.22	2.47	0.98	0/+	+
Middle Bairenkonda landscape	9. lower pediment slope (well field B of fig. C.4, see text)	43		2.38			+	+
sample areas on phyllites, small pediments	10. thalweg and adjoining area (well field A of fig. C.4, see text)	38		2.06			+	+
	11. weathered upper pediment slope	100		2.35			-	0
Cumbum landscape see text	12. gently sloping interfluve near dissected thalweg	63	8	1.98	1.62	0.28	0	+
Vempalli landscape	13. lower pediment slopes, see figure	102		2.26			0	0/-
Granite landscape	14. lower parts of weathered interfluves, see fig. C.7	66	30	1.61	1.36	0.45	-	+
	15. ibid	66	23	1.36	1.18	0.47	-	+
Nandyal landscape	16. flat interfluve, weathered shales approx. 1.3 to 2 m. thick	133		3.35			-	-
landscape without relieve on flat lying fine grained rocks, shallowly dissected	17. ibid, with sheetwash traces	225		2.68			-	-
	18. lower extension of pediment slope of other unit, some sheetwash deposits, calcareous siltstones	633		1.22			0	0/+
Landscape on eastern metamorphic complex	19. lower pediment slope	72		2.96			+	+
	20. broad, flat drainage divide	34		2.76			+	+
pedimented area with sand cover	21. large pediment, recharge by seepage from reservoir	70		3.06			+	+
	22. ibid	41		3.06			+	+
	23. ibid	74		2.87			+	+

Figure 3

Notes: 1. All samples are in clusters, except in the granite area. In the well fields (see colom 2a) no individual wells could be distinguished.

2. * ibid - refers to the same morphological conditions of another, often nearby area, where well clusters have been sampled.

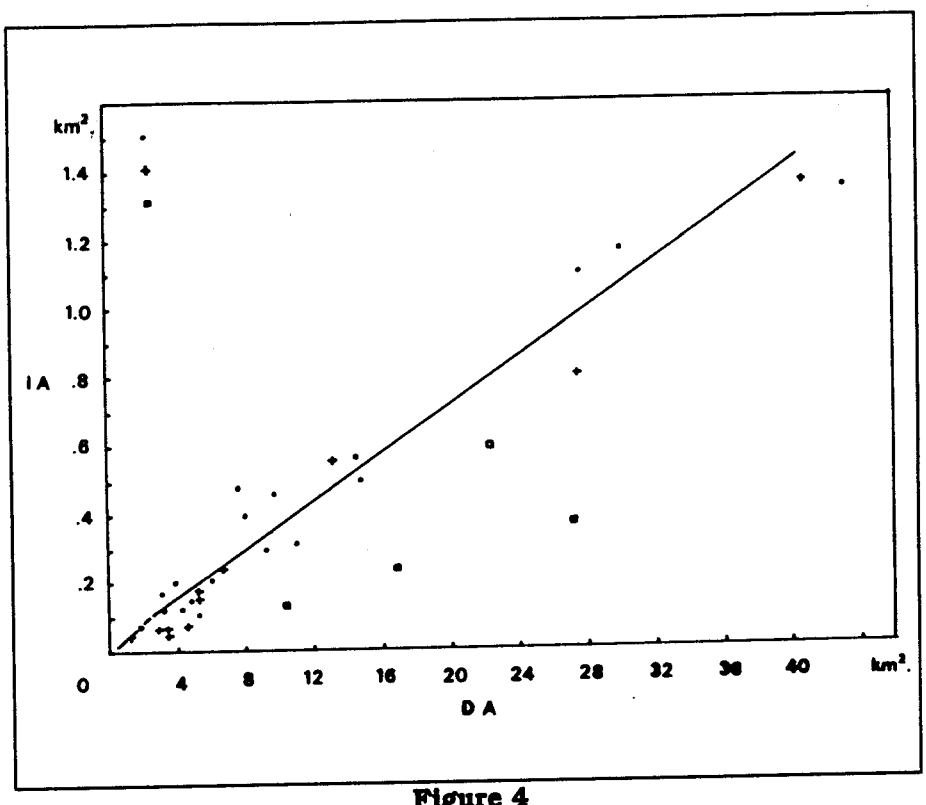


Figure 4

Area irrigated by reservoirs (IA) as a function of catchment area (DA) for the landscape in the metamorphic complex.

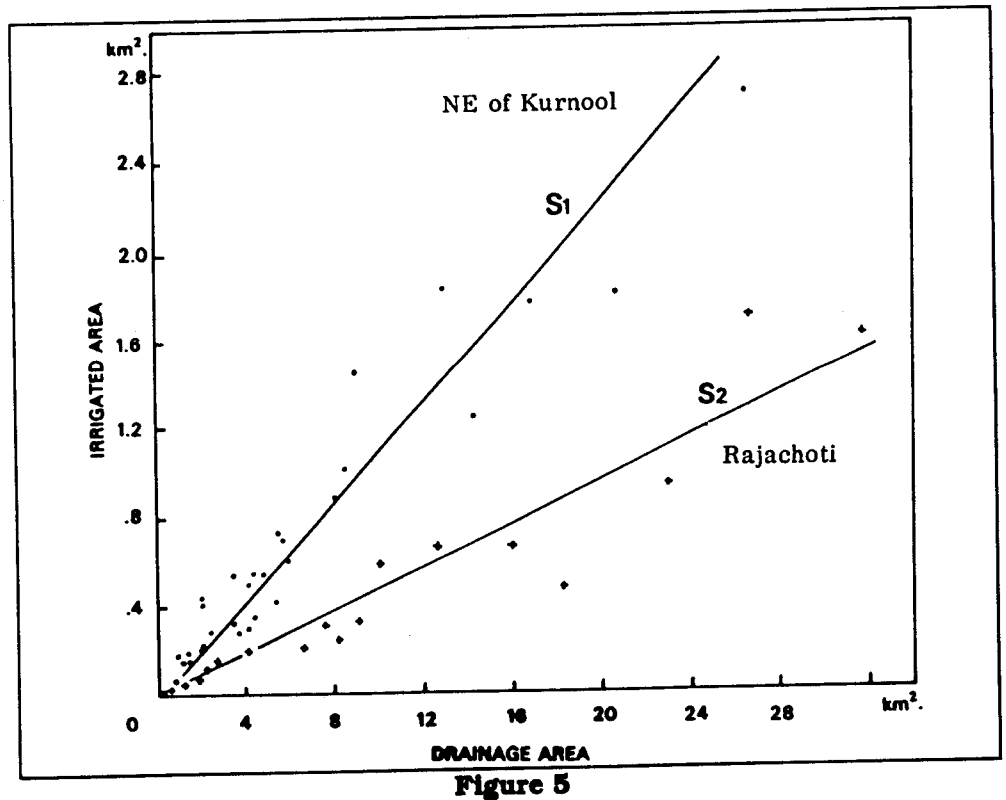


Figure 5

Areas irrigated by reservoirs as a function of the catchment area. Two sample areas are on the granites.

APPENDIX 6

Information on legislation of land ownership

Government of Andhra Pradesh
ABSTRACT

Land – Assignment of land for cultivation and for house sites to the eligible poor SCs, STs, BCs and other Weaker Section families – Issue of pattes in favour of eligible lady members of the family – Orders – Issued.

Revenue (s) Department

G.O.Ns.No.1666 Dated: 13.11.1994

1. The schemes for assignment of land for cultivation and house sites to the eligible poor constitute a major welfare measure undertaken by the government. The land available with the government and those accruing to it has surplus lends under the Andhra Pradesh Agricultural Land Reforms (Ceiling on Agricultural Holdings) Act, 1973 are normally being assigned or leased out for agricultural purposes. The assignment of land for agricultural purposes is only for landless poor directly, engaged in cultivation and owning not more than Ac. 2.5 wet, or 5.00 acres dry land and getting an annual income not exceeding Rs. 1800/- and as specifically indicated in the government orders of Andhra Pradesh Land Reforms (Ceiling on Agriculture Holdings) Act, 1973 and the Rules made thereunder. For the purposes of house sites, not only government land and surplus lands but even private lands are being acquired from funds made available by the Social Welfare Department. The house sites are being given under the scheme to those weaker sections' families including SCs., STs., B.Cs., and other E. B. Cs., who have no house sites or houses of their own and whose income are not more then Rs. 500/- per month or who do not possess movable/unmovable properties worth Rs. 5 000/-. The house sites are being allotted to the eligible poor families following the guidelines prescribed by the Social Welfare Department from time to time. For all practical purposes a married couple or an unmarried adult male without a site or a house is being treated as a family for the purpose of allotment of a house site.

2. According to existing practice, government are assigning lands either for purposes of cultivation or for house sites in the names of eligible male members of the family. Assignment of lands in the names of female members is made only in exceptional cases when a lady is a widow with dependent children. Government have already assigned, substantial extends of land (both Banjar as well as surplus land) at their disposal to the weaker sections of society both for purpose of agricultural and house sites. According to assignment policy, the lands assigned are heritable but not alienable. Though the lands sanctioned are legally inalienable the assignees often resort to illegal transactions, the out come of which is that for al purposes they lose their land. Though alienation of assigned lands is prohibited under the AP Assigned Lands. (Prohibition of Transfers) Act, 1997, its objective has been frustrated by such illegal transactions. Government have therefore decided that in future the assignment of all available lands i.e., Banjar lands or surplus lands accruing under land ceiling laws or lands acquired by social welfare department for purposes of agricultures of house sites be made only in favour of eligible female member of an eligible family as against the present practice of assigning than in favour of eligible male members of the families.

3. Government accordingly direct that in future, assignment of all available government land including surplus land under ceiling and land acquired by the Social Welfare Department for purposes of cultivation or house sites be assigned in favour of the female member of the eligible families (excluding minors or those who are otherwise not qualified to hold property), exclusively, subject to satisfying the prescribed rules or provisions of the concerned Act for such assignment.

4. Where there is only eligible family without a female member who is capable of taking and holding property legally, the land be assigned in the name of the eligible male member in that family.

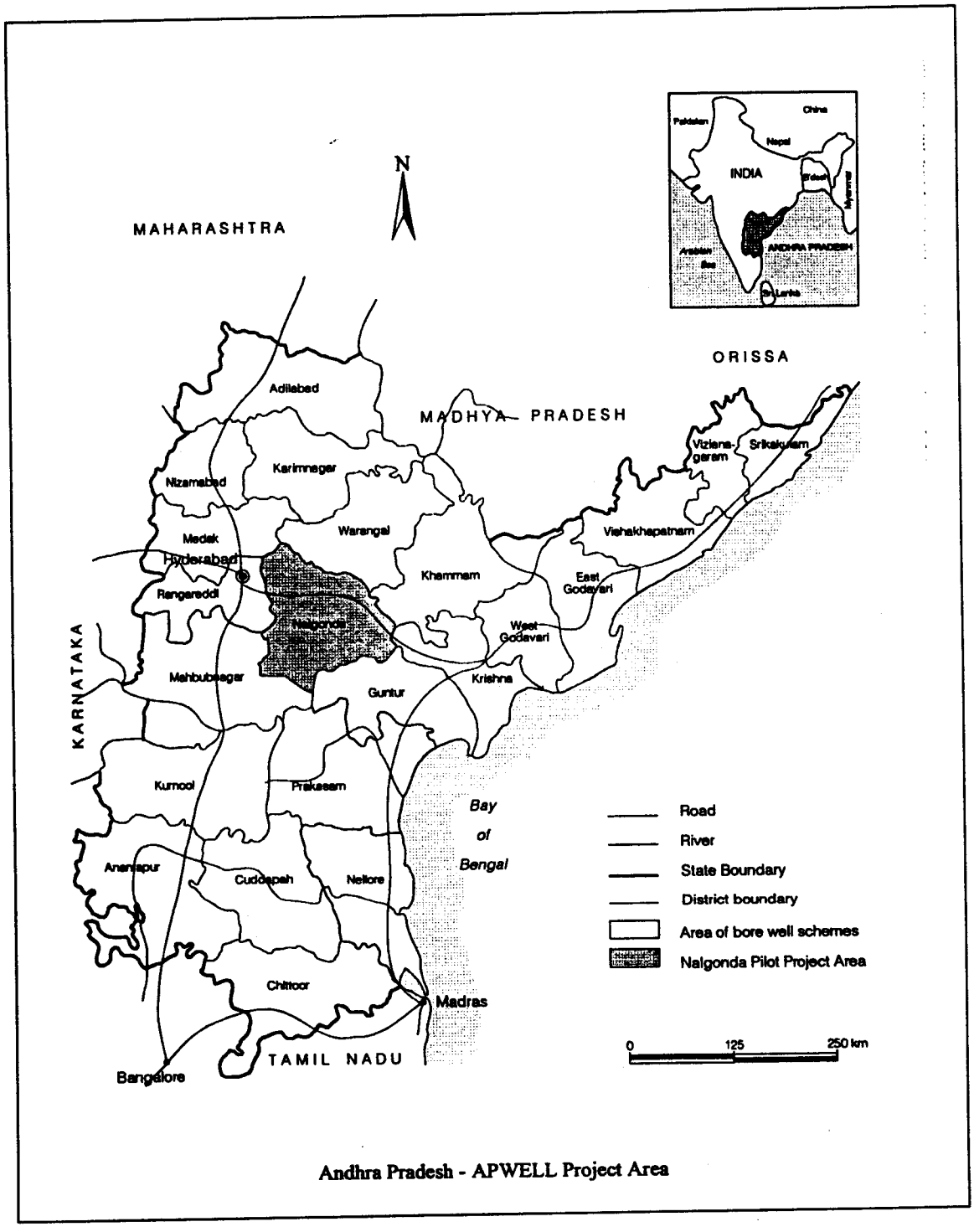
5. Care however should be taken to see that the assignment of land cultivation or a house site is not made in the name of a female member if the family has already been provided with land for that purpose in the name of any of its members.

(By order and in the name of the governor of Andhra Pradesh)

G.R. Nair
Principal secretary to government.

APPENDIX 7

Map of Andhra Pradesh



Andhra Pradesh - APWELL Project Area

APPENDIX 8

Geological map of the study area

The number of geological maps is limited. Therefore, it is possible that this advice does not contain a geological map. If you are interested in this map, please contact the Commission for EIA. You will receive a map for free.

Commission for EIA
P.O. Box 2345
NL 3500 GH UTRECHT
The Netherlands

Telephone + 31.30 347 666
Fax number + 31.30 304 382