CAPACITY BUILDING CLIMATE PROOFING

COMMUNITY PROJECTS SEVA MANDIR

UDAIPUR, INDIA

Produced by ALTERRA, Seva Mandir
Commissioned by ICCO

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Summary & Conclusions

Communities at village level report climate change through temperature rise, reduced sunshine during monsoon, more intensive and local downpours with longer dry spells and more variation in yearly precipitation. They also experience impacts of climate change: shortage of drinking water, reduced crop production because of less rainfall and diseases, hardship for animals because of heat, less fodder and drinking water as well as reduction in labor productivity of workers and skin diseases and heat strokes.

During the village meetings future scenarios were formulated based on extrapolated impacts which were linked to future climate projections. The communities formulated adaptation measures for their home-yard, agriculture and environment, including aim and strategies. During the planning for the future, climate change was mainstreamed in their desired profile of the future being sustainable development. Depending their situation and possibilities their strategy was more conservative or more innovative.

Approaches and concepts as developed in the preparation phase and adjusted during the field visits worked out well: visiting the village twice, linking climate effects with local impacts, extrapolating impacts to scenarios, assignment of excursion to hotspots, discuss adaptation measures for climate change in relation to other drivers, work in group sessions on domains like home-yard, agriculture and environment, giving a place to gender and concerns in daily, seasonal and life long interests.

Population pressure and wage labour are dominant concerns for the expressed sustainable way of life in the village. Especially in Chhali which is close to Udaipur. Influence of the market (low cost food, timber, mining, freshwater reservoirs) and change of consumption pattern lay a permanent pressure on the watershed.

Seen the complexity of the ongoing changes including climate change a stronger networking with science, policy and development organisation would benefit the work of Seva Mandi in its role towards the communities. In addition this position can also bring experiences from the community operative for science and policy at district and national level and international fora.

Two of the five villages entered participated already in a 3rd visit for formulating a more integrated package of measures to cope with climate change. Other Seva Mandir activities can be very well incorporated in this programme, like education, youth care, health, soil and water management, agriculture and forest regeneration. Inspiration for new initiatives can be based on integrated forest management and (future) services of the watersheds downstreams of the river like irrigation areas and urban areas (drinking water, less flooding and erosion of infrastructure, less sediment in reservoirs, firm base flow, fruits, medicines). A extention of the programme for communities in the other Seva Mandir blocks is advisable.

Progress on mainstreaming climate change within Seva Mandir programme as well as clear steps in mutual strengthening the relation with science, policy and development agencies are essential steps that have to be made.
As far as possible this process will be in co-production with feed-back from the consultant and ends in November 2010.

1. Introduction

Objectives

The objectives of this study are to strengthen the regional capacity to incorporate climate change trends in local developments, aiming at:

1. climate scenarios for the concerned area at relevant local scale;

and to support:

2. the assessment of midterm climate change impacts and analyze the effectiveness of already proposed measures (climate proofing);
3. the assessment of scenarios based on long term climate and socioeconomic trends, the assessment of options and formulation of adaptation strategies;
4. the identification of measures and the formulation of a plan for implementation, monitoring and review.

Figure 1: Udaipur district in Rajasthan on the map of India

In the start-up period the formulation of the activities has been scaled down to the field situation, and fine tuned to the following activities:

1. to check with communities awareness on climate change, the effect and impacts,
2. to identify measures to respond on short term and to anticipate on longer term changes based on climate projections 2070 (6 models, 2 scenarios)
3. to realize possible limitations and opportunity for the farming systems on the long run.
4. capacity building for Seva Mandir and formulate conditions for enabling environment.

Seva Mandir

This programme has been implemented with Seva Mandir – a local NGO in Udaipur district, Rajasthan, India in the period of July, August, September, October 2010 with an assignment from august 26 to September 7 financed by ICCO. Seva Mandir is a local NGO with 250 staff and focussing on strengthening self governance capacities in 626 villages and 56 urban settlements since the last 40 years, reaching 70.000 households and 360.000 people of which 65% trible. The working areas comprises 6 blocks with its own administrative responsibility and 6 zones each with 3 coordinators for 20-30 villages. In the villages are committees according the activities developed. In total Seva Mandir has more than 25 projects operational (see annex 5b).

The area of study

Villages visited in Udaipur district lay on 400 to 700m above sea level in Avaralli Range. Most farms have mix agriculture; 70% is smaller than 1 ha.

Land use in an average watershed is: during Kharif monsoon (july/sept) maize, millet, rice, (cotton) Rabi (october/march) 2nd crop mustard, gram, wheat and Zayd 3rd crop green gram, pulses. The cultivated area (26% of the area) depends heavily of the rainfall in the monsoon and in the other seasons on water availability in top soil, in reservoirs and as groundwater. An important area of these watersheds are forest (42%), revenue land (25%) and grazing lands (7%) which green up during the monsoon.

Climate

Climate condition in Udaipur: Temperatures vary between 6 degrees average in January till 39 degrees in May before the rains of the monsoon start. The rainfall rainfall is about 600 mm per year but variations are high according the monsoon. The extreme variation in the last year helped the farmers to realize future climate variability. ET is average 1950 mm per year.

Rainfall data sets were available over 35 years Jhadol and Udaipur rainfall, temperature, humidity wind and evapo(trans) piration.

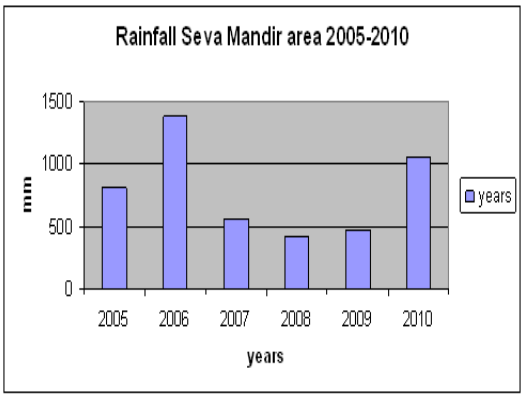


Figure 1: yearly rainfall in Udaipur

Higher temperatures and unstable microclimate condition lead to bigger spatial and temporal variability with higher rainfall intensities in local showers and longer dry intervals.

Main drivers: population growth (diet and land pressure), migration (survival and consumption pattern, market (threats & opportunities), environmental services (river basin and biodiversity)

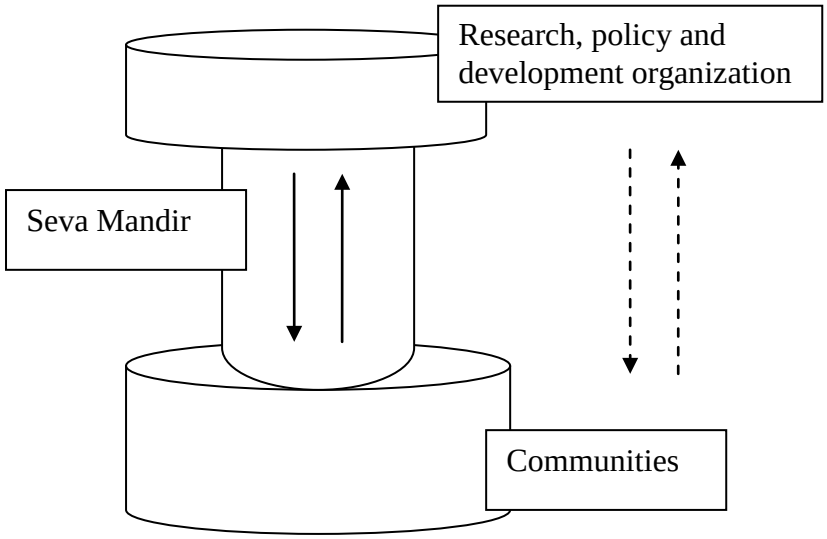
2. Methods and concepts

2.1 Capacity building and climate proofing

During weekly skypes in July, August the object of the study and approaches were formulated step-by-step. This started with the decision to combine the capacity building with the climate proofing of Seva Mandir projects by creating a atmosphere of co-production, learning by doing and intensive programming.

In this innovative atmosphere concepts and approaches were to be developed even during the implementation phase concerning: approaches in the villages, the concept on climate change and the role of Seva Mandir.

Figure 2: Position of Seva Mandir as enabling environment



Role of Seva Mandir connecting communities with research, policy and development agencies

The follow-up is the third phase of the programme monitored through skype interactions. The initiative is at Seva Mandir to set priorities in 1. mainstreaming climate change in their organization, 2. develop a plan for representative villages of all blocks for strengthening resilience and adaptation to climate change integrated in existing plans and 3. strengthen the relation with others institutes at district and national level.

2.2 Approach in the villages

Cooperation by the villagers and proper information could only be obtained if a sphere of trust and interest was built up with the village communities. In stead of a overnight stay in the village it was chosen to visit a village two times: first a shorter visit followed by a more extensive visit about one week later. The first visit was used to present the issue of climate change and collect the first observations, the impacts and possible respond measures. That

Seva Mandir was involved was for certain an important factor especially as a follow-up programme was foreseen for project formulation.

In between the first and second meeting the farmers were to prepare an excursion to hotspots of climate impacts or locations were measures were to be taken. During the intermediate period the team visited some climate change relevant institutes and further defined the programme of the second visit; final choices even were made pending the situation during the 2nd visit.

The second visit started with the field excursion were the situation around crop, well or dam site was explained but also the impacts of a even more extreme climate event were discussed as well as any type of opportunities or obstacles for the implementation of suggested measures.

Back at the village the excursion was reported back to the meeting followed by a further inventory of climate change effects and their impacts. This was used to built a future scenario for the village based on extrapolated impacts rather than climate change indicators. Main issues were chosen and work groups assigned to formulated appropriate measures sometimes even mentioning aims and the main strategy.

For the capacity building of Seva Mandir it was important that the meeting with the communities as well as with the relevant institutes in Udaipur and Delhi was shared by Seva Mandir staff. A first reporting of the field work was realized on the last day with a wider group of about 20 staff and representatives of some research and policy institutes.

The activities were implemented in co-production as for example the climate projections were done in Wageningen with ground check on climate data sets provided from Udaipur. The data sets came form the University of Agriculture and Technology (MPUAT) in Udaipur which also provided climate change trends over the last 25 years. Rainfall data were available from about 20 meteorological stations of nearby Tehsils mainly for the interest of the Irrigation department and Forestry.

In a follow-up programme Seva Mandir organize a programme in the villages, a screening of the other projects and a linkage with relevant institution at district, state and national level. In total 3 village visits already has been realized and a strengthening of cooperation with the agricultural university on Climate change in 2010.

3 Climate trends and climate projections

This chapter indicates how the climate projections has been established. Annex 3 shows this more in detail with considerations for future use.
During the preparation the field visit finally use has been made of regional climate modelling (RCM). The coarse resolution of GCMs makes it difficult, though not impossible, to assess future climate change in Rajasthan from the models. IPCC AR4 provided therefore only projections of climate change for a larger region in South Asia (SAS).

Within this project, scenarios will be used that capture the possible climate changes that can be expected for a large part of the state of Rajasthan in India. Most climate change projections are made for the 21st century, but in this project we will limit ourselves to climate change projections which are representative for 2050 and 2070.

The simulations for the 21st century are simulated using the various emission scenarios (IPCC SRES scenarios, SRES: IPCC Special Report on Emission Scenarios) and are projections of future climate change. Figure 1 shows a scheme in which the various emission scenarios are described in more detail. The SRES storylines were constructed on two axes, i.e. the degree of globalization versus regionalization, and the degree of orientation on material versus social and ecological values. The four clusters were given simple names (see Figure 1). The storylines describe developments in many different social, economic, technological, environmental and policy dimensions. The storylines do not have a particular order, but they are listed alphabetically and numerically.

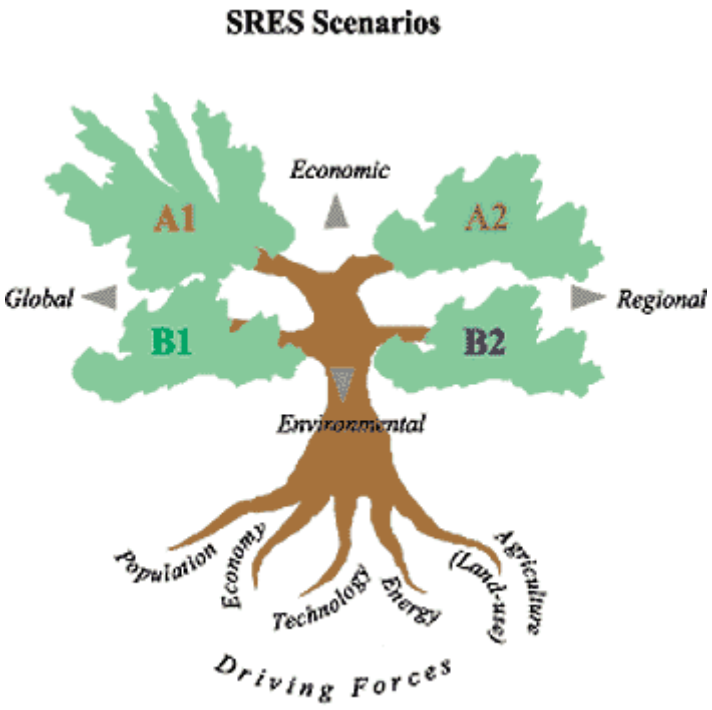


Figure 3 Schematic illustration of SRES scenarios. The four scenario "families" are shown, very simplistically, as branches of a two-dimensional tree. (IPCC, 2000)

The new regional projection method was used developed by EU Watch project. The advantage of this projection compared with the global scenarios is that the resolution is finer (0.5 x 0.5 º) and that the projection is bias corrected. These finer scenarios are based on two SRES-scenarios: A2 (“business as usual”) and B1 scenario (“sustainable path”). Within WATCH the bias correction is applied with the following models: ECHAM5, IPSL, CNRM-C3 with an observational database which is used for the bias correction.

The results shown in this paragraph focus on Udaipur district . Figure 4 shows the projections of temperature for the three models and for an ensemble of the models. This will be done for both emission scenarios A2 and B1. The ensemble is simply the arithmetically average of the three models per scenario.

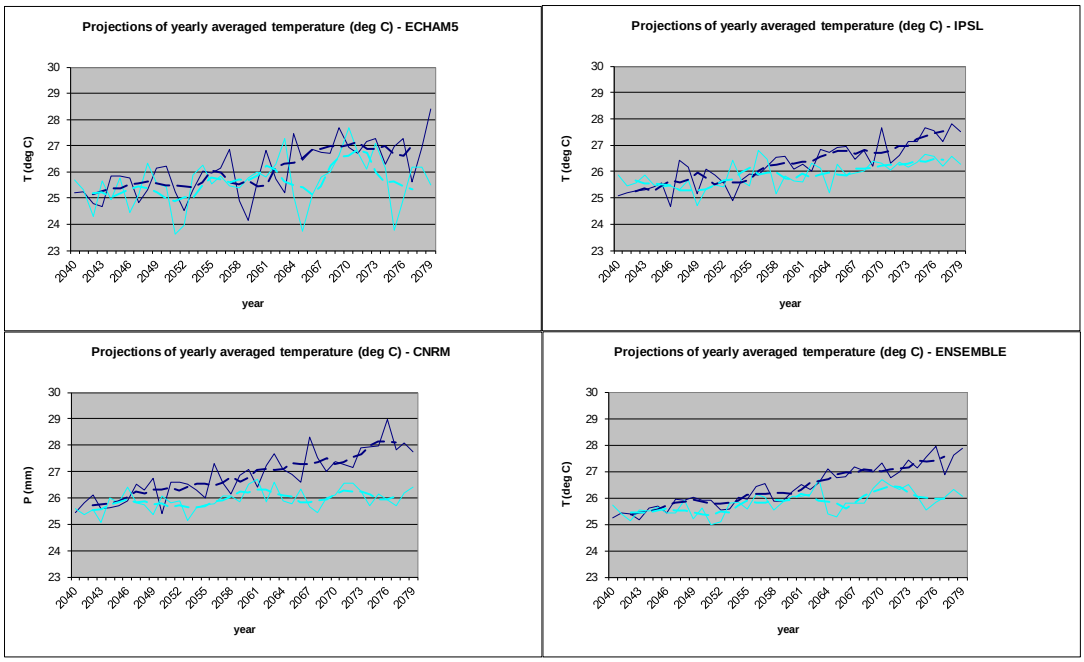


Figure 4: Projections of temperature at Udaipur for ECHAM (upper left), IPSL (upper right), CNRM (lower left), ensemble of models (lower right). Blue: A2 scenario (dashed: moving average of 5 years), light green: B1 scenario (dashed: moving average of 5 years)

While looking at the results for the downscaling experiment performed for Udaipur we can certainly see a trend in all models that the average yearly temperature is about to rise in the A2 scenario. In the (moderate) B1 scenario this rise is not so clearly seen. Under that condition mitigation also takes place. The IPSL model shows a rising trend in temperature of about two degrees in the A2 scenario between 2040 and 2080 and one degree in the B1 scenario. The ECHAM model shows a lot more variability between years and shows a cooling trend in the decade 2070-2080 for both scenarios. If we compare the projections with the observed temperature we can clearly see that the average temperature is clearly higher in the projections, regardless of the scenario or model used, than in the observations.

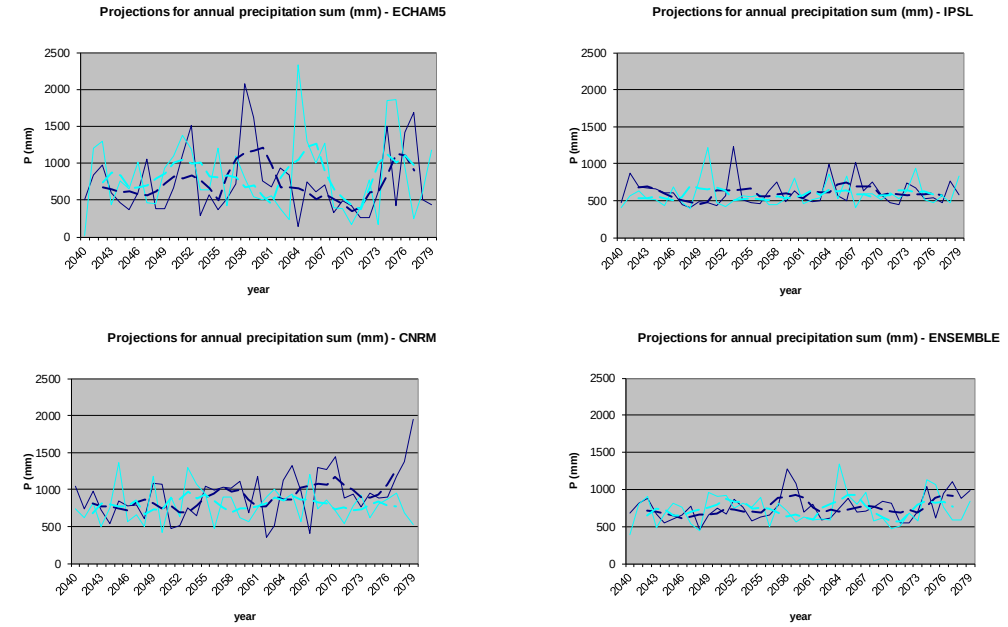


Figure 5: Projections of precipitation at Udaipur

Figure 5 shows the climate projections of annual precipitation at Udaipur for ECHAM (upper left), IPSL (upper right), CNRM (lower left), ensemble of models (lower right). Blue: A2 scenario (dashed: moving average of 5 years), light green: B1 scenario (dashed: moving average of 5 years). There is a large difference between the models with the ECHAM model showing years with annual rainfall sums exceeding 1500 mm. Overall it is hard to distinguish a trend in the rainfall. Only the A2 scenario in the CNRM simulation shows a clear rising trend in annual precipitation.

COUNT(2040-2060)	EC_A2	CNRM_A2	IPSL_A2	EC_B1	CNRM_B1	IPSL_B1
p>50 mm	60	69	6	56	66	3
P > 100 mm	6	13	0	5	18	0
P > 150 mm	0	1	0	2	4	0
COUNT(2060-2080)	EC_A2	CNRM_A2	IPSL_A2	EC_ B1	CNRM_B1	IPSL_B1
p>50 mm	47	91	4	62	39	5
P > 100 mm	4	20	0	3	8	2
P > 150 mm	1	5	0	0	2	1

Table 1: Projections of count of certain precipitation events at Udaipur for all three climate models and two emission scenarios

The extreme events are not really visible in these graphs and therefore Table 3 is designed. This table shows the occurrence of a certain event per day in the climate projections. We have defined a daily rainfall sums of at least 50 mm as an extreme event. The period of 2040-2080 is split in two parts to show if a change is observed in the extreme events. We can conclude from this table that only one scenario (CNRM_A2) show a significant increase in extreme events. The other scenarios show no change or even a decrease in extreme events. In this analysis we also see a different in the various models that are being used in this study. The IPSL model shows the lowest annual sums of precipitation and also has a low count of extreme events.

4 Sites selection, projects and programming

4.1 Site selection

Once it was decided to visit a village two times it was also clear that 4-5 villages would be sufficient for regional coverage and still practical for implementation: however with an intensive campaign character. From the 6 blocks (see annex 5a) there has been given a priority for areas high in the watershed with a strong topography of the Avaralli range (1000-1200m). Forest was the climax vegetation for the 5-700 mm per year. Tribal areas of the Bills with subsistence agriculture and some orientation to Gujarat for wage labor. As 5th location an area relatively poor and oriented towards Udaipur. In general the block office was at 1'5 to 2 hours drive and the villages at an additional hour drive.

	Kherwera		Jhadol		Badgaon
	Gadunia	Nichla Talab	Dhala	Som	Chhali
Institutional development	strong	Recent	medium	good	good
Position in watershed	hillside	Valley	foothill	foothill	hillside
Welfare/ prosperity	good	Low	good	low	low
Agriculture based	strong	Low	high	medium	low
Access to cities	medium	Far	medium	far	near

Table 2: Consideration used for the selection of the villages for the climate proofing survey

In a follow-up stage Seva Mandir will use this experience to initiate the climate proofing process in villages in remainder blocks.

4.2 Climate proofing Seva Mandir projects

Of the more than 25 Seva Mandir activities implemented in the villages the sensitivity to climate change was indicated as well as their potential support to a possible adaptation programme was indicated (see annex 2b) Of the most climate sensitive activities the climate indicators were identified and potential measures for strengthening resilience and adaptation. Health, drinking water, land and water use like for agriculture, livestock, waste lands and forests are obviously the most sensitive aspects in rural livelihood (see annex 2c). These aspects have been checked during the sessions with the community.

In the follow-up phase this long list of projects may be checked by Seva Mandir staff on their sensitivity to climate change as well as on their support to adaptation measures required to anticipate on climate change. As examples can be mentioned: education to be integrated with the development priorities in the villages, or blocks. This may lead to a consistent and integrated plan of adaptation.
At the same time it contributes to the mainstreaming of climate proofing in the Seva Mandir organisation. Yearly budgets may be (re)allocated accordingly with a priority to no-regret measures with a long term perspective.

4.3 Programming of the visits

The travel schedule was set during the preparation period (see annex 1). The programme in the villages was developed by try and error and similar in each village. A report on the field visits is in annex 2 and on the visits at the institutes in annex 3.

The goal, approaches and set-up of the programme was presented at a meeting at Seva Mandir on the first day (august 26)

1st round (august 27-29)
Presentation of the team, intentions and activities of the visit
Inventory of climate effects and impacts on livelihood
Confirm trends in climate change
Make inventory of possible measures
Announce 2nd visit for 1 day within a week time

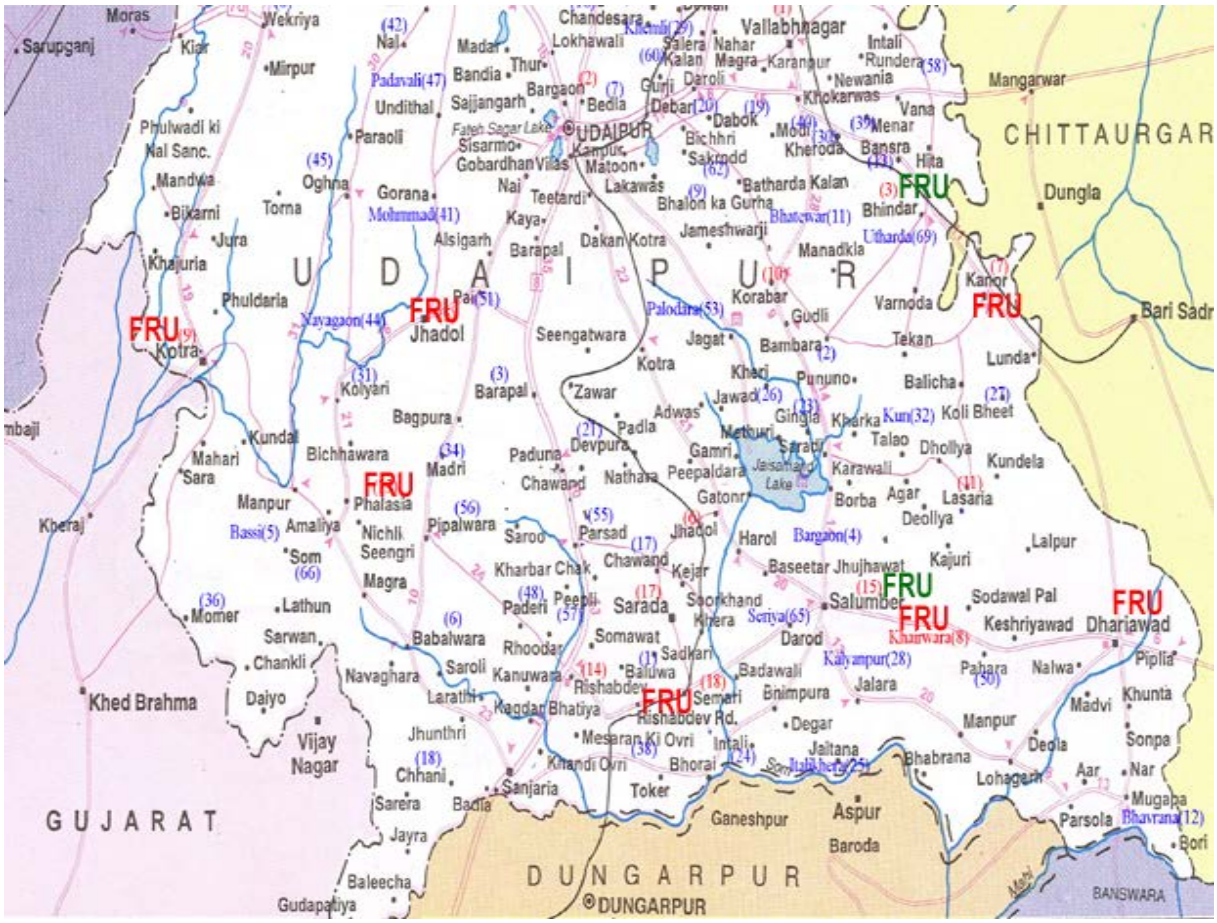
Interim period (august 30-31)
Communities prepare visit to 'hotspots' on impacts to discuss consequences and possible measures and continue reflection on climate change making climate change effects and impacts as specific as possible (document).

Seva Mandir staff visits relevant departments, institutes and consultants to exchange experiences and search for cooperation including invitation for end presentation. The approach and questions for the 2nd visit were prepared.

2nd round (September 1-5)
1.Collective field visit to ´hotspots´ of CC relevant sites to allow group discussion on actual issues, future CC impacts and possible measures (smaller group of key farmers)
2.Plenary meeting with summary of field visit and discussion on impacts and possible measures.
3. Presentation of the persistency of climate change and a likely '15 years from now' scenario including possible critical thresholds for the sustainable livelihood.
4. Prioritize most sensitive problem areas for the community and compose 3-4 groups including one women group. Issues may be: livestock, agriculture, use of forest and waste land, dry spells during Rabi, health and nutrition, drinking water and irrigation, ….
5. Group sessions: Discuss consequences of the 15 years scenario with possible change in livelihood and formulate no-regret and measures anticipating on change.
6. Report back from the minutes and plenary discussion;
7. Plan for follow/up in village committees and at Seva Mandir level.
8 Plan next village meeting on climate change adaptation measures.

Meetings in Udaipur and Delhi (September 6 - 7)
Presentation of on the preliminary results for the Seva Mandir staff and representatives of institutes visited. Visit to ICCO regional office ad Teri institute in New Delhi.

In a later stage the Seva Mandir staff devoted a 3rd visit to the two Jhadol villages as to prepare for the 2011 planning.



Map 2 : Udaipur district and the project area including the rivers

5. Results from the villages

From the villages different types of information has been collected, like the perception of climate change by the community, the local conditions, attitudes, critical areas; potential strategies and the related discussions. The three major type of results are presented here:

1. Observed climate change and the impacts
2. Local climate scenarios
3. Adaptation strategies

In annex 4 more detailed information can be obtained for each individual village.

5.1 Impacts of Climate Change and other drivers

Information was collected during the 1st and 2nd round of field visits (see Annex 2 and 4)

During two and a half days 5 selected villages were visited for an exchange of experiences on climate change and possible impacts. It concerns the villages Gadunia, Nichla Talab in the Kherwara block, Dhala and Som in Jhadol block and Chhali in Badgaon block. As an average the villages consist of about 5 hamlets and 250 households.

During the two hour sessions about 10-35 farmers and four Seva Mandir staff were present. The following indicators for climate change and climate impacts were observed. In fact the communities were relieved by getting confirmed that their observations had a scientific ground.

Winters are warmer and shorter in the last 10 years;

- no ice layers visible in the early morning;
- no winter fog visible (when breathing) which indicate time of sowing wheat;
- higher winter temperature has averse on milky stage wheat and lower production

Summers are warmer

- people work shorter in government program to bring income to the village
- health issues for human and animals;

Monsoon period in last 3 years reduced from June-October 4 months to July - Sept 2,5 month. Total amount of rainfall in last 10 years is also less.
Monsoon behavior; at the start wind from SW (Arabian Sea) later from SE (Indian Ocean) 1stmonsoon was strong and has become less predictable now; 2nd monsoon is more stable.
Impacts
Amount of rainfall less

- low yield/ no planting certain crops: 1st season (maize, millet, jute,..) 2nd crop (wheat, mustard,.) 3rd crop (grams); vegetables gets irrigation from some wells.
- Level of wells for drinking water down (open well and hand pumps)
- Ponds fall dry once in 3 years (since 10 years)

Variability of rainfall: more intense rainfall, more local, longer dry periods especially after first rain

- some shallow soil crops, young crops and HYV suffer because extended drought period
- some (stronger)grasses pertain with implications on cattle (throat injuries)
- farmers don't know when to do the tillage of the land and the proper sowing

More intense rainfall

- erosion on slopes and some places along the river,

- crop slashed down by downpours and wind
- maize saturated by rainfall and high ground water.
- flooding of rivers, roads less accessible, broken bridge isolates some villages

Humidity and temperature, wind (in the past clear rainy days followed by some clear days now more cloudy during long time) with:

- disease in maize and low productivity
- plague of new type of insects while earlier plagues have been away for 10 years
- increased malaria and dengue

Other drivers of change

Population growth causes more pressure on the land,

- cultivation of waste land
- less waste land >less fodder > more animal diseases > reduction of livestock per family > less capital, manure and balanced diet (milk)
- cutting of trees for fuel and timber> less biodiversity + less soil and less water in soil
- introduction HYV for higher production resulting is less tasty and less balanced diet causing more diseases
- less natural fruits, vegetables and valuable plants

Change of consumption pattern

- change of taste in urban area > lower prices
- less income and daily (Jalgaon) and seasonal (Kherwara, Jhadol) migration with all kind of issues
- less labour in village whereas the agriculture system (land use and number of cattle and need for grazing lands persists

Market issues

- Aggressive promotion of HYV and fertilizer by government (one year free of cost)
- Need for timber in building industry in Udaipur and Gujarat
- Need for river water in Udaipur by constructing Maansi-Wakkel dam.

Environmental services

May provide opportunities to the watershed to create income and subsidized facilities

- regular clean water flow to irrigated area and cities in Gujarat (no sediments, no floods, high base flow)
- providing specific products from the watershed (fruit, medicines, ..)
- biodiversity and attractive environment

Agricultural developments

Combined drivers with impact on land and increased sensitivity on climate change like the modernization of agriculture and push of HYV varieties

HYV are introduced for higher yields on the small plots BUT

- are more sensitive to drought (variability of rainfall)
- require fertilizer and pesticide which have impact on health of people and cattle (some note on shorter life expectation?)

Wheat is highly appreciated as ´cool´ food in summer (maize and rice are warm food for summer). Farmer invested in soil & water conservation, water harvesting, and irrigation especially for the 2nd season wheat. River dries up early in September so pump irrigation is needed exploiting valuable groundwater.

Hybrid wheat

- growing interest from local farmers requires more need for more water
- purchase of deep bore wells) >reduction of groundwater level > drinking water less available or from wells at bigger distance

5.2 Climate scenario at village level

In the process with the community it was consider that a proper language was most relevant to convey the message of the future climates. For this reason the team developed a method that could be called climate triangulation: more certainty about a feature can be derived is it is defined (located) from three different directions.:

1. villagers reported about their weather related observations of change.
2. a comparison was made climate indicators and trends based on data sets from Udaipur and Jhadol and checked if the were in line. In fact this already gave a reasonable expectation for the coming 10-15 years.
3. the information of future climate projections than was used to see if these trends were persistent towards 2040-2070 or that towards the end any dip occurred.

These three sources together formed the basis for the future climate projections as we used it in the communities. The severe droughts of the last 3 years helped to the villagers to visualize the possible changes.

For the local climate scenarios the down scaled climate projections has been mentioned but clarified with the extrapolation of the experienced impacts for the coming 15-20 years, like: goats are the only livestock, also maize experiences production risks in dry and in humid season, at least one month no drinking water in the wells and hand pumps, no water for irrigation of 2nd and 3rd crop in 3-4 concessive years; in rainy years very intensive rainfalls which hardly can be stored and causes erosion.

During the 2nd visit to the villages, the participants were presented how a possible climate in future could look like and what kind of impacts or options this would provide them. The story we told them was based on the triangulation of our observations: (1) local observations of climate and impacts, (2) meteorological trends which confirmed them and (3) climate projections for 2040 and 2070. The climate impacts and indicators were very well recognised by the community; directly as climate indicator or their impacts on the environment and society.

The table below shows that during the wet monsoon period the number of sunshine hours reduces with the years. This increases the humidity and the incidence of insects and diseases like in maize as the farmers report.

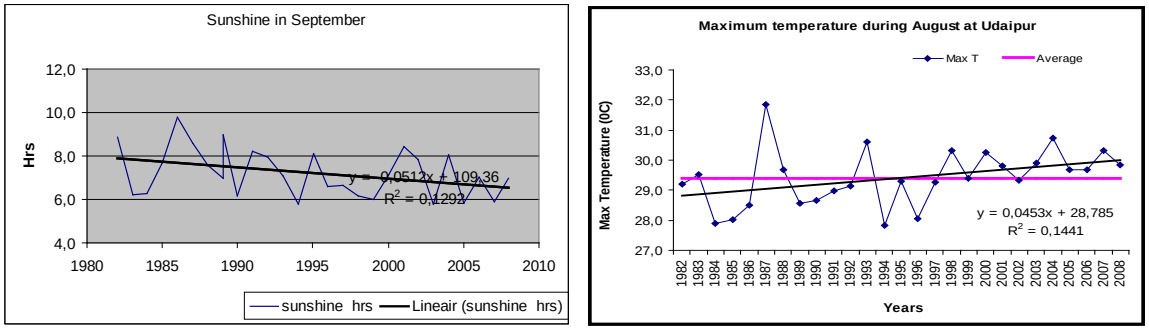


Figure 5: Decreasing number of sunshine hours and temperature rise during monsoon

In relation to the meteorological trends, the climate project were in the same direction but with more variability. In the communication the climate change projections were presented

through their impacts rather than the climate indicators as they are more realistic to perceive. As boundary a period of one generation of 15 years was suggested and any period thereafter. The following projected climatic changes and impacts in the region were presented before the participants started their work groups:
Climate change in the years to come:

- Temperature is likely to go up- 1 degree in 15 years and 2 degree in 30 to 60 years.
- Rainfall distribution will be variable in place and time; heavy downpours will be followed by long dry-spells between the rains; weather remaining more cloudy affecting humid and warm conditions.
- Rainfall will go up slightly over the years with a high variability in rainfall within years, and a number of dry years will increase in the hydrological cycle (3 in 5 years). The duration of the monsoon will changed accordingly.

Scenario after 15 years will lead to:

- Crops requiring more water could not be cultivated; due to dry spells seed germination will be problematic.
- Cultivation of second and third will be difficult.
- Goat will survive- need of more grazing land.
- Human health- more incidence of dehydration, difficult to work requiring physical labour.

In the working groups and discussions measures anticipating on these developments were to consider rather than those to react on that. Also other drivers in the region were taken into account. Measures were anticipating on change, preferably no-regret and could also make use of positive aspects of climate change. It was noted that the actual time scale in the discussions was not considered as an obstacle.

5.3 Cooping with future climate

The 2nd visit was devoted to the strategies needed to cope with climate change. The community was asked to organize an excursion to vulnerable sites and locations where adaptation measures were planned. Then a sketch was given of a possible future climate according the preceding paragraph. After which the participants where ready to discuss the strategies how to anticipate on the future changes. A short characterization of their ideas is presented in the table 2.

In principle 3 working group were established of which the homeyard by the women, the agriculture and the natural resources group ‘forest soil and water’. There always was a leader and a reporter in each group who shared the results in plenary for further discussion.

The 2nd series of meetings were in the beginning of September and unfortunately coincided with the Gavri festival which is organized in the agricultural lean period. Local theater groups travel between the villages which is specially an attraction for the women; certainly a reason why they were less present only during 3 of the 5 meetings.

5.3.1 Adaptation strategies

In this section one can find an overview of the strategies and measures the community come-up with to respond to future climate change. Because their basic condition is not similar and they experience different drivers the aim of their strategies also is different. The table below gives a characterization of the individual villages. More detailed information per village is available in Annex 4.

	Kherwera		Jhadol		Badgaon
	Gadunia	**Nichla Talab**	**Dhala**	**Som**	**Chhali**
Conditions					
Institution	Strong	Recent	Medium	Good	Good
Families	180	200	300	400	200
Topography	Hillside	Valley	Foothill	Foothill	Hillside
Agriculture based	strong	Low	High	Medium	low
Migration	Gujarat prominent	Gujarat Noticeable	Udaipur Limited	Udaipur Limited	Udaipur eminent
Adaptation					
Aim	Sustainable market oriented agriculture	Sustainable livelihood	Sustainable market oriented agriculture	Sustainable forest oriented livelihood	Strengthen rural livelihood in dual economy
Strategies	Diversification consolidation	Conservation of water resources	Develop opportunities	Environmental based economy	Urban income for environment
	New crops and markets	better crop and tree selection	Intensify and mixt crops	Seed bank with traditional crops and trees	Climate and labour based crop selection
	Conservation of water sources	Water conservation	Integrated water management	Use appropriate soil and water conservation	Water conservation
	Regeneration of forest	More of various uses of trees	Integrated forest management	Invest in forest potential	Labour efficient S&W conservat.
	Cattle for milk and manure	More drought and heat adapted buffalo	Diversify home-yard options	Fodder for cattle on stable for manure.	Adjust cattle size to available resources

Table 3: Type of adaptation strategies for the individual villages

Homeyard
Aims:
At least one well with hand pump in hamlet which always provides water.
Nutrition of good quality for good health.
Cash comes form cash crop and not from migration

Measures:
Introduce biodiversity forest for local medicines to maintain health.
Fruit trees and vegetables are needed for health; select less sensitive varieties
Livestock: keeping goats require less water
Harvesting of rooftop water for livestock.

Agriculture
Aims:
Sustainable agriculture with use of manure, mix cropping
Crop potential which can stand dry and wet years.

Strategy:
Defensive strategy with some experiments and innovations

Measures:
In wet years winter crop is possible; In dry years less production, fodder is needed from storage.
Maintain proper rotation of crops during the seasons to maintain moisture and fertility.
Prediction of character coming monsoon by Pune at district or geophysical region. Local calendar not correct anymore.
Try to get more water from runoff, groundwater or pipeline from far.
Consider other more resilient crops like rainfed rice,..
Activate seed bank to increase higher variety of seed also the more resistant varieties, less sensitive to soil saturation and with better taste.
Maize can continue to grow. If dry spells and maize fails, than sow 2 shorter crops after., chilies can grow if warm. Millet is good if market can be assured and require high labor
Winter crop becomes more important if monsoon crop fails; assure more irrigation water for HYV varieties for higher yield.
Introduction new fruit trees for additional income and as fence for farmyard. Fruit trees on slopes, grains in valley
Find buffalo type which can survive heat and drought
Some measures against more insects

Forest soils and water
Aims:
Conservation of vital wells for drinking water
Maximal storage of rainfall in groundwater and reservoirs

Strategy
Combine conservation of natural resources and effective use of the products
Try to develop a scenario (Ghali): how to handle with less labor and saving the environment with financial support from wage labor and other stakeholders.

Measures:
Collective decisions for priorities between drinker water and agriculture in case of less water.

Look for better sides for boreholes and hand pumps, protection of resources of groundwater or run-off.
More water storage in small ponds for rice, mustard, vegetables and cotton,.
One bigger reservoir is more effective than several dams. Allow village to build dams higher than 2 meter little own labor so if possible subsidized by Irrigation department.
Forest with functional drought resistance trees and richer biodiversity. Lots of forest; need good conservation and take benefits from it as well. (gum, goah flower). Combination of dam and fish farming.
Stimulate vegetation on the slope and erosion contours
Make controlled use of forest (also suggestion of Forest department)
Make more use of revenue terrain.

5.3.2 Dilemmas, obstacles and opportunities

Dilemmas in operation
In the management under changing climatic conditions the community is faced with several challenges which results in adaptations in regulations and new arrangements.

The division of labor over wages, agriculture and protection of the environment is changing. Seasonal or daily wage labor gives the opportunity for additional income in the off-season. This implies that maintenance work and labor investments like for soil and water conservation experience shortage of labor as well as the routine work of cattle watching

Water has to be allocated for irrigation, for livestock or drinking water. Specially during the excursions to boreholes the discussion on priorities on water use between agriculture and drinking water became evident. In general the drinking water will get priority above agriculture use if other wells or ponds dry up. To which extend the farmers will be compensated has not been made clear. Mechanisms at the level of drinking water, cooling of livestock and human beings has not been discussed as such.

Land for agriculture, for feeding the animals and for protection of the natural resources.
The extreme rainfall variations expected in future climate can be anticipate by more careful management of the waste land, forest and revenue land. More than agriculture the livestock is making use of there soils both for meat products and as manure for agriculture. The need for cattle seems to be in conflict with the access to and way of management of these lands. Solutions seems to be available but not yet easily accepted.

Obstacles for change
Population growth will persist as 2 sons per family (and as many daughters?) are considered as a sound and required family composition.

Wage labor provides some relief for family income but also a reduction of the available labor in the village for maintenance of the system and investments for the future.

A changing consumption pattern does change the cash flow of wage labors and their family of which most part is spent in the urban area. It also change the market of products from the village; millet is an example of a high quality and (drought and rain) resistant crop. However the demand in the urban area drops and the price is no stimulus for this labor intensive crop.

Two neighboring farmers :				
50		**50**		**100**
Four sons become active farmers :				
25+5	**25+5**	**25+5**	**25+5**	**120**
Two sons migrate, two sons take land in shareholding :				
30	**25-10**	**30**	**25-10**	**90**

Figure 7: farm productivity under migration conditions

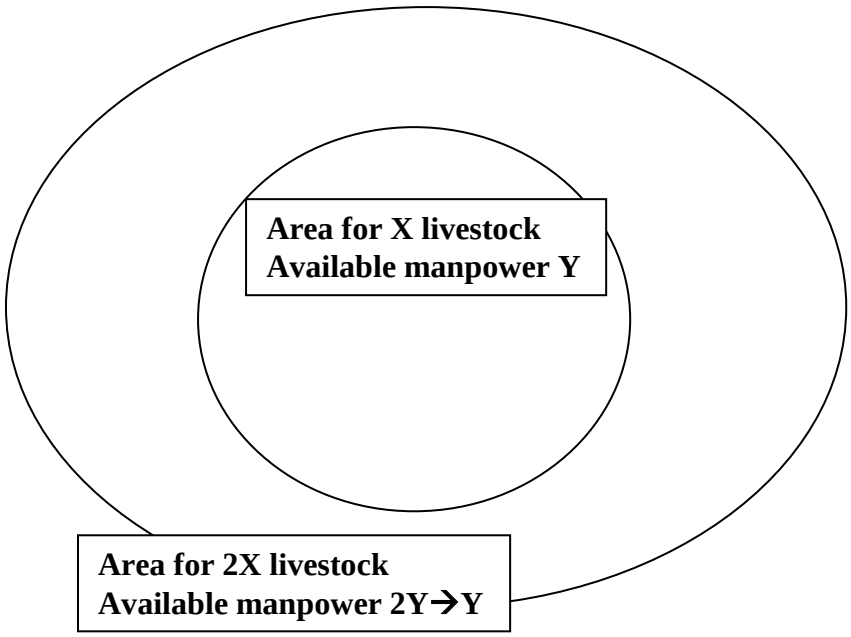


Figure 8 : Manpower to invest in safe areas fro grazing and fodder leaves the communities

New opportunities

- A higher temperature may allow for new type of fruits and other product which find its market to the urban areas.
- New development at the meteorological institute in Pune may increase insights in monsoon behavior and make the coming rainfall more predictable and help farmers in a proper crop choice and selection of the most profitable seed variety.
- At the same time there are new and still hidden demands from the down the river basin and especially the urban area which need to be made convertible to the communities in the river basin. Some fruits and medicinal plants might be commercialized as well as tourist tracks and homesteads.
- Soil and water conservation in the forest and rainfed agriculture of the watershed provide services to the drinking water of the urban area, controlled floods in the rivers and related infrastructure, less sediment for the reservoirs and higher base flow for the irrigated areas.
- Consumers of these environmental products like the cities and the irrigation department and forest department might start to reward these services by more intensive cooperation with the communities in advise and support.

At the end of the meetings the village committee was pleased with the fact that they observation were confirmed by science, that progress made on scenario building and formulating measures.

The committee was asked to pick-up the conclusions of the meeting and look for practical ways for future implementation. Seva Mandir mentioned a 3rd meeting at the end of September about 4 weeks later, to prioritize the measures and formulate a set of integrated measures and plan for operation.

6 Results from the institutes

The impacts of climate change as observed in the villages, and a proper anticipation on future scenario's will require an integrated set of adaptive measures which need involvement of departments and institutes at all levels: local regional and national. It is therefore important that Seva Mandir initiate and strengthens its working relations with relevant organizations.
For that reason appointments were made with organization for science (Universities in Udaipur, and Teri institute in New Delhi), policy (Livestock and Forest department; meeting with Irrigation department was postponed), and development (ICCO-New Delhi, AFPRO and private consultant).
The concern about impacts of climate change in future was shared by the organisations and the observations on climate change and impacts were confirmed by statistics.
The mind-setting by the collective built-up of longer term scenarios are well appreciated. On individual measures support can be expected from the various institutes. On the development of a more integrated package of adaptation measures was no concrete experience but much interest to participate.

Science
The MPUAT university recently erected a multi-disciplinary climate team organizing a first National seminar on Impacts on Climate Change in January 2011. For this climate proofing pilot they already provided Seva Mandir with useful climate data set over the last 30 years. Farmer observations can be confirmed like on new insects an diseases in maize and drought and temperature tolerance of traditional varieties; millet and hosgram may have a future for rainfed farming if equally promoted as the 'green revolution' products. Water harvesting is considered as a low cost and effective measure to overcome the dry spell after 1st rain of the monsoon as well as for Rabi irrigation by recharge of groundwater. On the other hand research shows that yields may decrease with temperature rise because closing of the leave stomata.

The geography department of the University Mohan Lal Sukadya supported the long term planning issue of climate change scenarios. In town planning in Rajasthan only the water supply to Kota has been well secured. The recently built Maansi-Wakal dam just saved Udaipur from a disaster. It confirms the role watershed (communities) play in services for the downstreams and urban areas. Planning for 20 years may be too short for investments that last 100 years. The question remains how can visionary way of planning -like for climate change- can be integrated in the spatial planning routines.

The Earth Science and Climate Change division of Teri Institute work on climate vulnerability and adaptation and apply a training-research approach in their work on 'Policy making under uncertainty' in 5 states. Among others in the High-Noon project, which projects global climate effects for Himalaya through national and district level to local case studies. They are concerned that climate change influences the already existing problems on the main issues water, agriculture and health.
The community based CC impact extrapolations at village level as applied in the pilot are probably more reliable than climate modelling with all its uncertainties. For the time being 'no regret' measures are preferable. One is not yet sure at which moment visionary based robust and innovative measures becomes important. (It can go wherever you feel appropriate. But it should certainly be part of the analysis/ recommendation. Reason- in the name of CC, donors want innovations/ radical measures. But, I feel many times even the old techniques (no

regret) are sufficient. Except that the CC science should feed into the planning). If needed use pilots
For Teri as well as Seva Mandir there are sufficient lines for cooperation and to exchange information linking national policies with local practices, perceptions and opportunities.

Departments
The Veterinary section of the Livestock department reported that the number of livestock increased but might be reduced per family. Cows and buffalo's may suffer more from temperature rise and drought and goats appear more resilient. Goats are also favoured for emergencies (ATM: any time money/ milk), easy to transport, for low value transactions, less sentiments for selling as for cows. However goats are noted destructive for the environment especially on sloping lands.

The Forest protection already has a close working relation with Seva Mandir. Most concern goes to a wise management of forest and revenue lands: red mud on the road after rainfall is a good indicator of need for soil conservation. It is considered that forest are better protected if if the community can also profit of potential products. I stages small parts could be replanted and after successful protection by the community over 10 years the terrain can be used for controlled grazing and fruits, flowers and wood: Joint Forest Management (JFM). In cooperation with the communities valuable products have been identified, multiplied and protected already. Within the existing legislation pilots already could be made together with Seva Mandir.

Development
AFPRO was NGO before but works now as a consultant firm. Capacity building of designers and users on wise design and proper operation and maintenance is considered more important than structure design especially on soil and water management issues.
For a capacity building programme on climate change they made a timeline interview with people of different ages asking for climate change effects, impacts and how to cope. As timeframe the clients (Ministry of Environment and Forest) preferred 2030 projections rather than 2080, which would be too insecure. Modelling work was done in Indian Institute for Tropical Meteorology (IITM) in Pune.

Main concern of ICCO were the learning initiative of this climate proofing for the future, the application in other areas and a possible up-scaling trough training. It was re-assuring farmers experiences were confirmed by local climate data which were adequately available. The extrapolation of climate impacts was considered as a practical tool especially were it coincide with climate projections. New was the experience with mind-setting on a future scenario on homeyard, agriculture and environment resulting more in a reshuffle of existing measures at various policy levels rather than a complete new activities.
For up-scaling the focus should be in the concepts and the approaches and the process in the communities rather than the formulated measures. For mainstreaming climate change at governmental levels one should identify the proper enabling environment for communities and supporting services.

7 Capacity building

For the mainstreaming climate change in Seva Mandir programme three issues have been preselected on possible impacts of climate change: health included food and drinking water, agriculture and soil and water conservation.
In addition it is important to check the sensitivity to climate change of all other activities as well as identifying the possible opportunities climate change may offer. Both presentations initiated already a wider internal discussion on the role of Seva Mandir and the relation between the various activities in the communities.

The capacity building in the preparatory phase and during the consultancy worked well mainly because the intensive and focused way of working, the urgency of the issue of climate change in the work of Seva Mandir and the fact that all parties shared the similar objectives.

With the experience of both visits to the villages and the feed back from the institutes it has been advised to realize a 3rd meeting in the five villages to formulate a package of measures which are feasible for financing from the various sources. The cooperation from the communities than has lead to a reference for future actions. In November already the villages in Jhadol where visited and formulated their long-list of measures.

With this experience also a complete process in the other 3 blocks of Seva Mandir should be possible including the Udaipur settlements. The urban area will deal with completely different issues but will include the experiences of the migration part of the wage earning issue in the village and therefore close the circle for understanding and integrated measures.

The complexity of the climate change the impacts and adaptation measures requires that Seva Mandir can operate in a network of science, policy and development institutes for exchange of information, for creation of innovative ideas and for support in research and implementation. This creates a proper enabling environment for further strengthening of climate proofing of Seva Mandir programme. A first visit on this issue to these institutes and an invitation for the presentation of the preliminary results at Seva Mandir were the first steps which deserve to be continued in one form or another by Seva Mandir.

More concrete activities in the cooperation with regional, national or international institutes are desirable on issues like:

- climate projections and monsoon forecasting (Pune, MPUAT),
- planning on the mid and long term at various spatial scales,
- research innovations in agriculture, seed bank, fruits, medicinal plants.
- linking up with politicians to identify priorities and formulate programmes that create new options for the communities.

Environmental services provided by the watershed could be a new concept at river basin scale for investments with a common interest as can be expected for drinking water, river protection and irrigation issues.

From a strong institutional network Seva Mandir can better programme its activities to support adaptation measures to strengthen resilience within the communities. Meaning ful activities are: education for awareness raising, youth care -linking job opportunities with responsibilities for the village-, health programme, drinking water and sanitation, innovations in agriculture and integrated soil, water and forest management. As far as possible this becomes visible in the coming 3 year plan.

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Annex 1: Itinerary

Consultancy Climate Proofing from August 25 to September 8, 2010.

Wednesday 25-26/8 : travel from Wageningen, The Netherlands to Udaipur, India.

Thursday 26/08: meeting and presentation at Seva Mandir, Udaipur (Shailendra Tiwari; Arun Poojary; Ronak Shah, Neelima Khetan; Bidisha Kumari)

Friday 27/08: Kherwara office, Wasim.(block coordinator), Dinesh (NRM), Dhaneswar (institutions), Kannaiyalal (zonal worker) and villages Gadunia and Nichla Talab

Saturday 28/08:
Jhadol office Kripa Shankar Joshi (block coordinator); Devilal Katara (NRM); Sabjiram(agriculture); and the villages Dhala and Som

Sunday 29/08:
Badgaon office, Manoj Pailwal (block coordinator) and village Chhali

Monday 30/08: visits to Department of Livestock, Animal Husbandry Veterinary clinic, Udaipur; Dr Jajendra Lodha, assistant director; Dr. Joshi head veterinary laboratory.
Action for Food Production (AFPRO), Udaipur, P.K. Dutta (unit manager); Forest Department, Conservation of forests, Udaipur, A.K.Upadhyaya (chief); Maharana Pratap University of Agriculture & Technology **(**MPUAT**),** Udaipur, Dr. S.R. Maloo, (director of Research); Dr. T Hussain (insects), Dr. Amit Trivedi (plantpathology), Dr. G.S. Chauhan (agronomist), PK Singh (rain, soil and water management), mrs Kusumat (plantpathologist), Prem Solihki (meteorologist absent).

Tuesday 31/08: visit to
Geography department of University Mohan Lal Sukadya, Udaipur, Dr. N.S. Rathore, Dr. L.C.Khatri, Dr. I.M. Kayamkhani. Groundwater expert, Udaipur,Dr. J.C, Dubey

Wednesday 01/09: visit to Gadunia village, Jhaluram (representative), Kherwara;

Thursday 02/09: visit to Nichla Talab village, Devisingh (representative), Kherwara;

Friday: 03/09: visit to Dhala village, Kalulal (representative), Jhadol

Saturday 04/09: visit to Chhali village, Chatraramji (representative), Badgaon

Sunday 05/09: visit to Som village, Shambhulal Kharadi (representative), Jhadol

Monday 06/09: presentation preliminary results at Seva Mandir, Udaipur

Tuesday 07/09: visit to ICCO regional office, New Delhi, Frederika Meijer (regional representative), Poonam Kaur (foodsecurity), Shaika Rakshi (climate change) and Teri institute in New Delhi, Sreeja Nair, Sneha Balakrishnan, Lingaraj GJ (climate adaptation group), Ashish Aggarwal (climate modeling).

Wednesday 08/09: return travel to Wageningen, The Netherlands

Annex 2 : Seva Mandir blocks and activities

2a Seva Mandir blocks

Relative Comparison of Blocks for Climate Proofing Study

Category	Characteristics	Badgaon	Girwa	Jhadol	Kherwara	Kotra	Kumbhalgarh
Population	Proportion of Tribal Population	Medium	High	High	High	Highest	Medium
Natural Factors	Rainfall	Medium	Medium	Medium	High	High	High
	Monsoon	3-4 months	3-4 months	3-4 months	3-4 months	4-6 months	4-6 months
	Temperature	medium	medium	cooler	warm	medium	medium
	Terrain	Medium	High	High	Medium	Medium	Medium
	Proportion of Common Lands	Low	Medium	High	Medium	High	Medium
	Water resources	medium	medium	medium	high	high	medium
	Major Livelihoods	Agriculture Labour	Agri, Labour	Agri, Labour, Livestock	Agri, Labour	Agri, Labour, Livestock	Agriculture, Labour
Capabilities	Education	Medium	Medium	Medium	High	Low	Medium
	Health	Medium	Low	Medium	Medium	Low	
	Status of Women	Medium	Medium	High	High	Low	Medium
Coping	Migration	High	Medium	Medium	High	Medium	Medium
	Institutional maturity	high	Medium	High	High	Low	Medium
	Proximity to District HQ	High	High	Medium	High	Low	Medium
	Influence of Urbanisation	High	High	Medium	High	Low	Low
	Association with SM	40 years	40 years	>30 years	>30 years	25 years	10 years

Source of information from Seva Mandir office Udaipur

Based on this analysis pilots for the study were selected in Jhadol and Kherwera for their representation of the regional characteristics and Badgaon because of the the specific sub-urban area problems that the community face there..

2b Seva Mandir projects

Table 1: Seva Mandir activities and climate change

1. activities *	2. Climate sensitive**	3. Adaptation support
Improvement people livelihoods	Health, erosion, roads, agriculture and forests	New priorities, more and new measures, adaptation
Building peoples capacities	Not	Awareness, knowledge, skills
Promotion and empowering village institutions	Renewed awareness short and long term threats	New priorities, short and long term oriented program
Aforestation programme	Longer droughts, intensive rains, torments, erosion of fertile soil	New priorities
Water Resource development	Possibly more but heavy rains, longer drought, loss of water holding capacity of the soil	Soil and water conservation increases productivity and water flow
Watershed development	Higher floods, less groundwater, more sediment, lower base flow longer droughts	Recharge groundwater, regulate withdrawals, adjust management to authorized prioritized demands
Agriculture development	Less production because other plagues and diseases, longer maximum temperatures, less rainfall	Resources; wellbeing; confidence and motivation
Supporting People's initiatives	None	Directed towards awareness, skills and investments
- Empowerment of village committees Gran Vikas Committees Delwara Urban Governance Project + Mitigation (CDM) - Social Empowerment	None	Increased awareness and decision making on new priorities and regulation of new activities
General health Services	Heat and plagues related diseases Less drinking water	Support clean and sufficient drinking water programme
- Children Education - Youth resource Centres/ Urja Ghar - Continuing Education - Early Childhood Care & Education - Child representation	Heat and transport (rain)	Awareness raising and new priorities, on improved infrastructure in road, drainage, buildings, water storage
- Youth photographers - Children's forum Child line - Integration of child-centred approach	None	Not special
- Monitoring & Evaluation Systems - Planning, Monitoring and Evaluation cell	None	Audits on impacts on temperature, droughts and rainfall impacts
Optional: Linking with external stakeholders	None	Screening of specific interests in river basin and sensitive sectors
- Research cell - Social Environmental Cell - Training cell - The Kunjru library	None	Focus on climate change: events, impacts and adaptation

* Seva Mandir activities as selected form the website

** see also table 2 on potential impacts

Annex 2 c Potential impacts of Climate Change

Table 2: climate change sensitive aspects in rural systems

1. climate sensitive aspects (see table 1 column 2)	**2. related climate indicators**	**3. measures for resilience and adaptation**
* pest/diseases, health, *human production *learning effectiveness in education	* extreme temperatures (+%C how many consecutive days) summer/monsoon/ winter * average seasonable humidity (dew)	* crop/ animal temperature tolerance, * weather forecasting * eradication programs
* crop/ animal production; * biodiversity, products from nature (green services)	* extreme drought period, start / duration of monsoon; * extreme winds * number of days maintaining root zone at within 'readily available moisture' for main crops/ trees/ pasture.	*study of monsoon behavior in continent * drought resistance, required seed varieties (short ripening) * water saving methods and techniques * reaction on the market (prices) * income and investments
* rural management system: crops, live stock, forests and pastures, biodiversity	* extreme drought period, start / duration of monsoon; * average temperature change (seasonable), evapotranspiration * average change daily rainfall * extreme temperatures	* crop/cattle choice, landuse change for water use and water conservation, * change agricultural/ rural system * future income generation, subsistence level
* groundwater supplement for drinking water/ gardens:	* demand: average temperature change (seasonable), evapotranspiration * supply: extreme rainfall events (hours?) in relation to infiltration/ run-off * average change daily rainfall	* soil and water conservation * drought resistant rain-fed farming * river basin approach * controlled groundwater use (techniques, legislation)

Annex 3: Climate Scenarios for Rajasthan

The climate change impacts will be addressed using climate change scenarios which are developed recently. Various scenarios, ranging from coarse to finer resolution, will be described in this chapter. The first paragraph deals with an introduction of climate change scenarios combined with a historical review of the development of climate change scenario. The current state of Global Climate Change scenarios are discussed first. The following section will deal with biases in Climate Change Scenarios and how to correct for them. We than give an analysis of the developed scenarios and discuss the successes and shortcomings of the development of Climate Change scenarios for the province of Rajasthan in India. Finally the conclusions and recommendations will be given

Introducing Climate Change Scenarios

Within this project scenarios will be used that capture the possible climate changes that can be expected for a large part of the state of Rajasthan in India. Most climate change projections are made for the 21st century, but in this project we will limit ourselves to climate change projections which are representative for 2040 and 2070.

Climate Change projections are performed on a global scale by various institutes in the world. This leads to an ensemble of models which have their own characteristics. Table 1 shows a selection of the Global Climate Models (GCMs) which are reported in the latest IPCC reports as well. The contribution of Working Group I to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) was released in 2007. IPCC (2007) assessed amongst other "the capacity of global climate models (…) for projecting future climate

Table 1 Selection of GCMs which are used in IPCC 4AR

Model acronym	Full name of model and institute of origin
CNRM-CM3	**CNRM** Météo-France/Centre National de Recherches Météorologiques, France
GIER	GISS-ER, NASA Goddard Institute for Space Shuttles, USA
GFCM21	GFDL-CM2.1 US Dept. of Commerce / NOAA / Geophysical Fluid Dynamics Laboratory, USA
INCM3	INM-CM3.0 Institute for Numerical Mathematics, Russia
IPCM4	**IPSL-CM4** Institut Pierre Simon Laplace, France
MIMR	MIROC3.2(medres) Center for Climate System Research (The University of Tokyo), National Institute for Environmental Studies, and Frontier Research Center for Global Change (JAMSTEC), Japan
MRCGCM	MRI-CGCM2.3.2 Meteorological Research Institute, Japan

MPEH5	**ECHAM5/MPI-OM** Max Planck Institute for Meteorology, Germany
HadGEM	UKMO-HadGEM1 Hadley Centre for Climate Prediction and Research / Met Office, UK
HadCM3	UKMO-HadCM3 Hadley Centre for Climate Prediction and Research / Met Office, UK

change. Climate model ensemble simulations were performed for the 20th and for the 21st century. The simulations for the past 20th century are used to validate the models. The simulations for the 21st century are simulated using the various emission scenarios (IPCC SRES scenarios, SRES: IPCC Special Report on Emission Scenarios) and are projections of future climate change. Figure 1 shows a scheme in which the various emission scenarios are described in more detail. The SRES storylines were constructed on two axes, i.e. the degree of globalization versus regionalization, and the degree of orientation on material versus social and ecological values. The four clusters were given simple names (see Figure 1). The storylines describe developments in many different social, economic, technological, environmental and policy dimensions. The storylines do not have a particular order, but they are listed alphabetically and numerically.

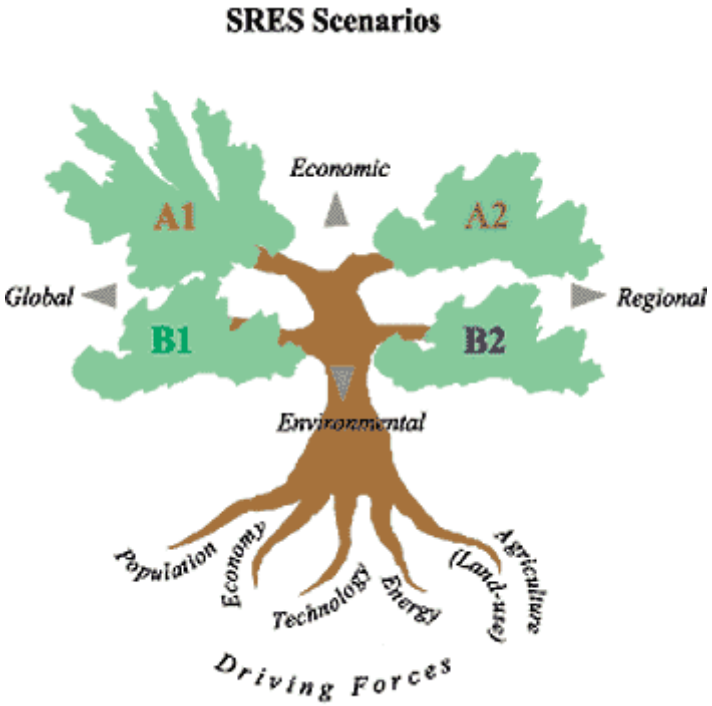


Figure 1 Schematic illustration of SRES scenarios. The four scenario "families" are shown, very simplistically, as branches of a two-dimensional tree. (IPCC, 2000)

A major issue in the application of climate change scenarios for an area the size of the state of Rajasthan has to do with the resolution in space of the scenarios. The state of most GCMs is that the resolution is in the order of several hundred kilometers. Recently, these models are improved so that the spatial resolution is finer as well, but these results are not yet reported and will not be treated in this report. The coarse resolution of GCMs makes it difficult, though

not impossible, to assess future climate change in Rajasthan from the models. IPCC AR4 provided therefore only projections of climate change for a larger region in South Asia (SAS). Next to the spatial issues, the IPCC 4AR underlines also how the spread in projections of hydrological changes is still too large to make strong statements about the future of tropical climates at regional scales (Christensen et al. (2007)). Given these shortcoming IPCC came up with the prediction on precipitation for the 21st century (Table 2). From these predictions it is

Table 2 Predicted precipitation change (%) for the next 100 years for the South Asia Region (A1F1 and B1 emission scenario), note that A1F1 is the fossil intensive emission scenario of the IPCC

	2010 to 2039		2040 to 2069		2070 to 2099	
Season	A1F1	B1	A1F1	B1	A1F1	B1
DJF	-3	4	0	0	-16	-6
MAM	7	8	26	24	31	20
JJA	5	7	13	11	26	15
SON	1	3	8	6	26	10

expected that precipitation will decrease in the dry months of DJF and will increase in the monsoon period. In the SAS region the precipitation increment will be more pronounced than in the rest of Asia. Precipitation figures are expected to increase, with a decrement of 5% in the winter period and an increment of 11% in the summer period. Results with a moderate-resolution GCM (1.5 x 1.5 º) showed that the shift in more intense rainfall events is due to the northward shift of monsoon circulation (Christensen et al. (2007)). A major source of uncertainty in the area is the influence of the El Niño Southern Oscillation (ENSO) on rainfall in the South Asia region. These figures are only estimates for the South Asia region, but are of limited use for Rajasthan and to answer the more local questions posed in this project. It is, therefore, at this moment of time essential that Climate Change scenarios are downscaled to a state level and even to a city level. This asks for special techniques and datasets developed within other projects which are coordinated by Alterra – Wageningen UR.

The application of climate change scenarios in policy also needs attention. There is a discrepancy between the timeframe at which policy makers want information for and the accuracy at which climate models can deliver information. Policy makers generally want information at maximum for the next 10 sometime 20 years. They also want accurate climate change projections for these time frames. However the current state of the art climate science is not able to deliver that information. In recent scientific articles (e.g. a recent Nature overview article titled “The Real Holes in Climate Science”) it was noted that “planners should handle them (regional climate projections, ed.) with kid gloves” and “All the problems, however, do not make regional simulations worthless, as long as their limitations are understood.” The result presented in the last IPCC report and the models used **for that are suitable to make climate change projection at 50 to 100 year timescales.** At shorter (decadal/10 year) timescales the initialization of the models becomes very important especially the sea surface temperatures. Data on sea surface temperature is still scarce and as a result it is difficult to properly initialize the models. Therefore model outcome **are not reliable for the near future and become much more reliable for 2050 when** the increased greenhouse gas concentrations become the main driver within the system. Similarly, when no change is observed in one or a few climate change scenarios for 2030 it cannot be assumed that climate will not change for that period it also does not mean that climate will change **but it is often better to look at the period beyond 2050 and backcast from there.** It must be noted that there currently is a large scale initiative in the climate science community to improve decadal predictions.

Global Climate Change Scenarios

It has already been mentioned that the IPCC scenarios are very coarse for the application that is needed within this project. Figure 2 shows an example of a variable field from the ECHAM5-MPI-OM model and from the CRU_TS3.0 global observation dataset. With a red circle the location of interest in Rajasthan is given in this figure (24° 06N, 74° 28E, Udaipur)

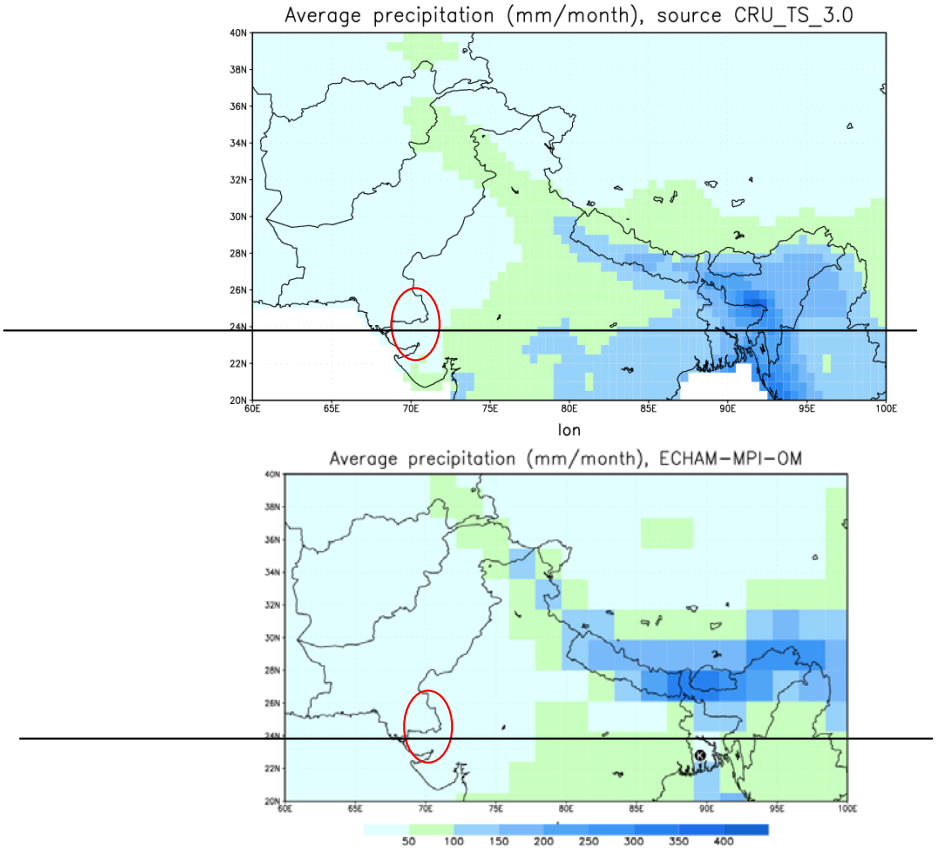


Figure 1 Monthly-averaged precipitation sum (mm/month) for 1901-2000 from observations (upper panel) and ECHAM-MPI-OM model (lower panel).

The representativeness of the IPCC scenarios for an area the size of Rajasthan is limited by the resolution which is used by the models. Also, the performance of each AOGCM (Atmosphere-Ocean General Circulation Model) is different per region of the world. A skill assessment was performed for the major river basin situated in India: the Ganges river basins. For the basin monthly averaged precipitation is calculated per model and compared with the observations. As observational database the high resolution CRU TS 3.0 data set (resolution 0.5 º or 50*50km) the Climate Research Unit is taken, which is successor of CRU TS 2.1 data set (Mitchell and Jones (2005)). For the period 1901-2000 the simulated monthly precipitation by the ECHAM-MPI-OM model is compared against the observed monthly precipitation, averaged over both river basins. It appeared that the performance of the ECHAM model was quite good when compared to the observations (ECHAM: 109.8 mm/month, CRU TS 3.0: 98.7391 mm). CRU is taken here as the ground truth, but recent studies (Biemans et al. (2009)) showed that there is a spread between the databases representing observational data. More recent databases (like the Asian Precipitation - Highly-Resolved Observational Data Integration Towards Evaluation of the Water Resources (APHRODITE)) might be more accurate, and might be used in future.

The scale mismatch of the large scale climate models and fine scale process-based hydrological models is addressed in the EU-funded FP6 (Sixth Framework Programme) Integrated Project WATCH. This project will bring together the hydrological, water resources and climate communities to analyse, quantify an predict the components of the current and future global water cycles and related water resources states; evaluate their uncertainties and clarify the overall vulnerability of global water resources related to the main societal and economic sectors." (http://www.eu-watch.org). Workblock 3 of this project will produce multi-model based projections for the terrestrial components of the global water cycle for the 21st century. During the course of this TA only output from the ECHAM5 model became available and thus only projections of this model were used. **The advantage of this projection compared with the IPCC scenarios is that the resolution is finer (0.5 x 0.5 º) and that the projection is bias corrected**. The method of bias correction is explained in the next section and is adopted from the WATCH project. These finer scenarios are **based on two SRES-scenarios: A2 ("business as usual") and B1 scenario ("sustainable path").**
Next to the spatial resolution, the temporal resolution is also an important issue if climate change scenarios are used to drive hydrological models. The WATCH-scenarios have a daily timestep, whereas the GCMs which are referred to in the IPCC report store most of the variables on a 6 hour timestep even though they use a finer timestep in the calculations. The WATCH scenarios are constrained in their timestep by the underlying databases which are used in the bias correction. These databases do have a 0.5 x 0.5 º, but only store their main variables (e.g. precipitation, temperature) on a daily basis. It depends on the application for which the climate data is used, which kind of climate database is actually needed.

Bias correction

Climate model are notoriously biased in rainfall. The errors in GCM daily precipitation afflict the entire intensity spectrum: a low number of dry days, which are compensated by too much drizzle, a bias in the mean and the inability to reproduce the observed high precipitation events (Christensen et al. (2008;Leander and Buishand (2007)).This is usually corrected using a "bias" correction. The most simple way to do it is to adjust every single historic rainfall event by the average change in rainfall. For example if the climate models project 10% less rainfall all rainfall events will be reduced by 10% to create a future scenario. The method is usually called the delta method. However, it is now fully acknowledged that not only the amount of rainfall will change but also the distribution. In very simple terms, if the average temperatures increases and the amount of rainfall is remaining equal, the number of rainfall events will decrease and the amount of rain for each event will increase resulting in more extreme events. **By how much extreme events will increase is still very uncertain this makes it difficult to develop reliable time series.**
Within the WATCH project a methodology is designed for correcting climate model output to produce **internally consistent fields that have the same statistical intensity distribution as the observations.** This has been referred to as a statistical bias correction. One of the assumptions while applying a hindcast derived corrections is that the correction still holds for the projected climate, which is not a trivial assumption (Trenberth et al. (2003)). The background of the bias correction is given in Piani et al. (2010) and part of this report (technical implementation) is put in the appendix.
Within WATCH the bias correction is applied on the IPCC climate change scenarios (A2 and B1 emission scenarios) of the following models: ECHAM5, IPSL, CNRM-C3. The observational database which is used for the bias correction is the CRU TS 2.1 database which has a daily time resolution and a spatial resolution of 0.5 x 0.5 º and not the aforementioned CRU TS3.0 database.

Climate Scenario Development

To assess the quality of the Climate Change scenarios and the CRU database which is used for the bias correction, it is of great importance to perform a comparison between CRU/GCM output and the actual observations especially when Climate Change scenarios are developed at a more local level. CRU is still a gridded product in which all observations within a 0.5 x 0.5 º gridbox are averaged. The meteorological variables at a more local level due to surface characteristics (e.g. topography, land use) might well be smoothed out. Figure 3 shows the availability of observational stations where rainfall is measured. From this figure it can also be seen that a hilly terrain with peaks above 1000 m is located at the western side of the area of interest. This might cause spatial differences in meteorological characteristics between stations in the west and east of this area. Temperature observations are only recorded at Udaipur (denoted with U in figure 3). For the analysis of the bias-corrected GCMs not all rainfall stations are used. The comparison between GCM output and rainfall observations is only performed at Udaipur and Jhadol (denoted as J in figure 3).

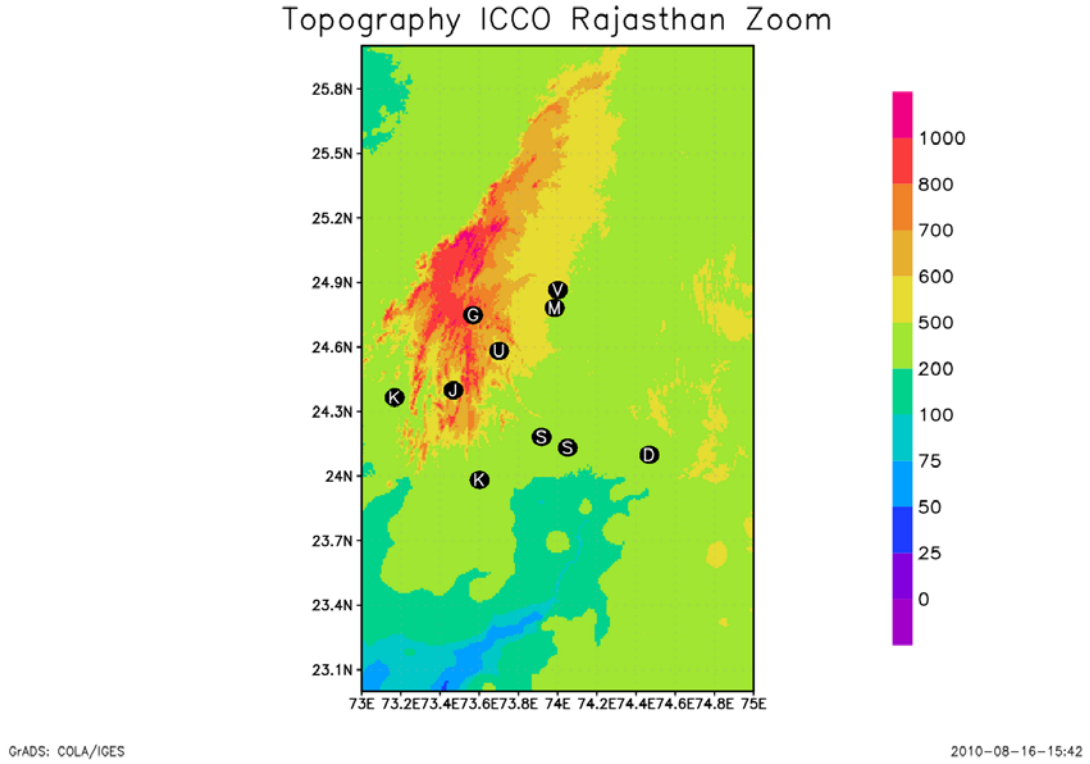
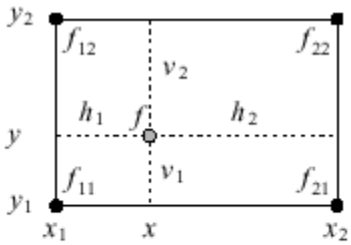


Figure 3: The topography (m) of the area of interest with the stations where rainfall is measured represented as black circles

The WATCH climate scenarios are used to obtain projected time series of temperature and precipitation for 2040-2080. The time series are created by interpolating WATCH climate scenarios to the station location. The interpolation routine used is the bilinear interpolation which is graphically explained in Figure 4. In this figure f_{11}, f_{12}, f_{21} and f_{22} represent for example temperature or precipitation on the WATCH and the point f represents a station to which the climate data is interpolated.



$$f(x_1, y) = \frac{v_1 f(x_1, y_2) + v_2 f(x_1, y_1)}{v_1 + v_2}$$

$$f(x_2, y) = \frac{v_1 f(x_2, y_2) + v_2 f(x_2, y_1)}{v_1 + v_2}$$

$$f(x, y) = \frac{h_1 f(x_2, y) + h_2 f(x_1, y)}{h_1 + h_2}$$

$$= \frac{h_1 v_1 f_{22} + h_1 v_2 f_{21} + h_2 v_1 f_{12} + h_2 v_2 f_{11}}{(h_1 + h_2)(v_1 + v_2)}$$

where $f_{ij} = f(x_i, y_j)$.

Figure 2 Mathematical illustration of the bilinear interpolation technique

Results

Validating the climate scenarios

One of the issues with climate scenarios is to check how the model performs against observations. Climate model simulation not only extend until 2100 but they start at 1900. Figure 3 shows the performance of the three models against observed temperature and precipitation records for Udaipur. It can be clearly concluded that the models have difficulties in simulating the right amounts of precipitation and also the right signal in temperature at a point scale. By applying a bias correction it was thought that the difference

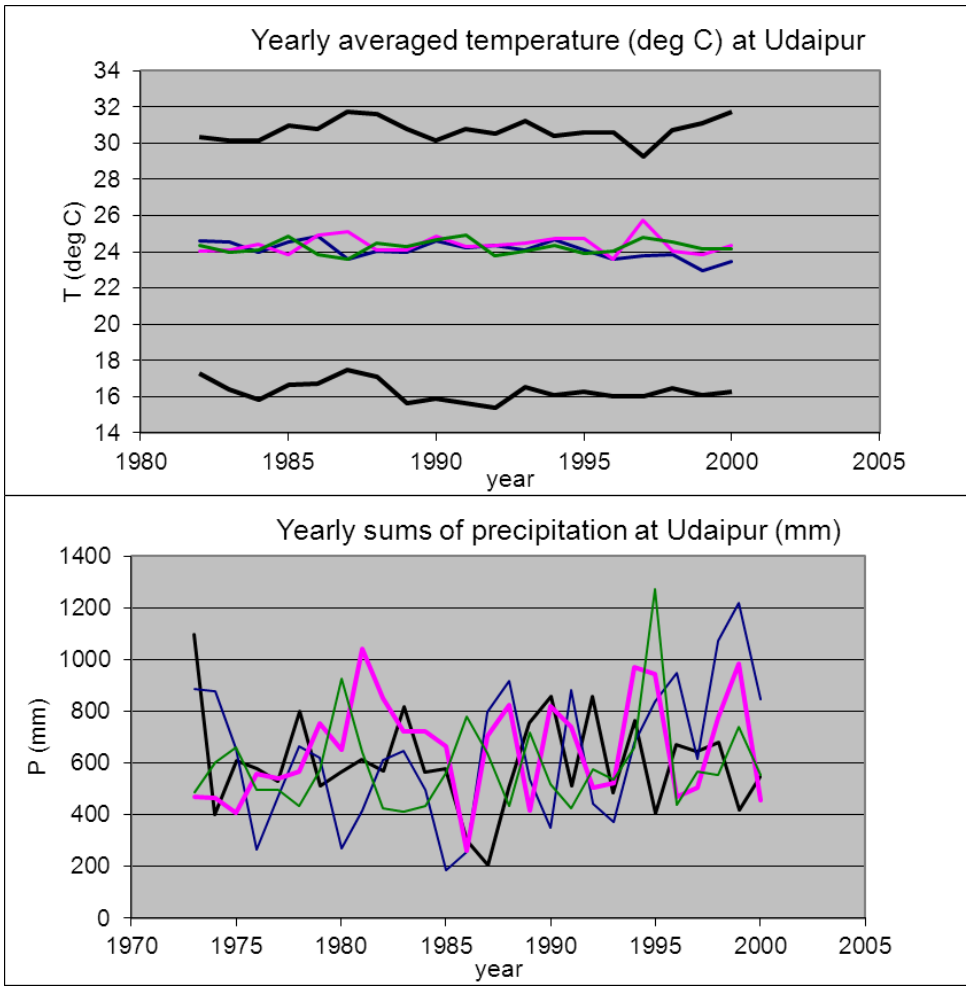


Figure 3: green: IPSL, pink: CNRM, blue: ECHAM, black: observations (Temp: minimum and maximum temperature, Prec: yearly sum)

between models and observations would be less. This is not the case which might be a result of the difference between the actual observed records and the database which is used for the bias correction (CRU – TS2.1). With this in mind we also have to assess the climate projections.

Climate projections

The results shown in this paragraph focus on Udaipur as the difference between Jhadol and Udaipur is not really significant. The projections for Jhadol can be seen in the Annex. Figure 4 shows the projections of temperature for the three models and for an ensemble of the models. This will be done for both emission scenarios A2 and B1. The ensemble is simply the arithmetically average of the three models per scenario.

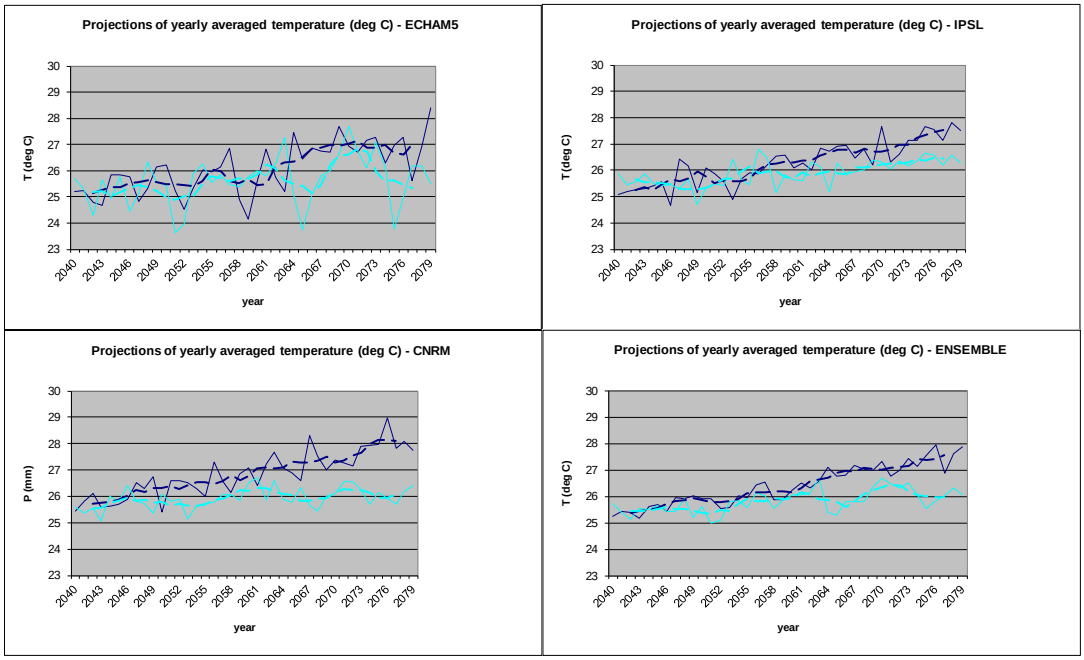


Figure 4: Projections of temperature at Udaipur for ECHAM (upper left), IPSL (upper right), CNRM (lower left), ensemble of models (lower right). Blue: A2 scenario (dashed: moving average of 5 years), light green: B1 scenario (dashed: moving average of 5 years)

While looking at the results for the downscaling experiment performed for Udaipur we can certainly see a trend in all models that the average yearly temperature is about to rise in the A2 scenario. In the (moderate) B1 scenario this rise is not so clearly seen and the model don't agree. The IPSL model shows a rising trend in temperature of about two degrees in the A2 scenario between 2040 and 2080 and one degree in the B1 scenario.

The ECHAM model shows a lot more variability between years and shows a cooling trend in the decade 2070-2080 for both scenarios. If we compare the projections with the observed temperature we can clearly see that the average temperature is clearly higher in the projections, regardless of the scenario or model used, than in the observations.

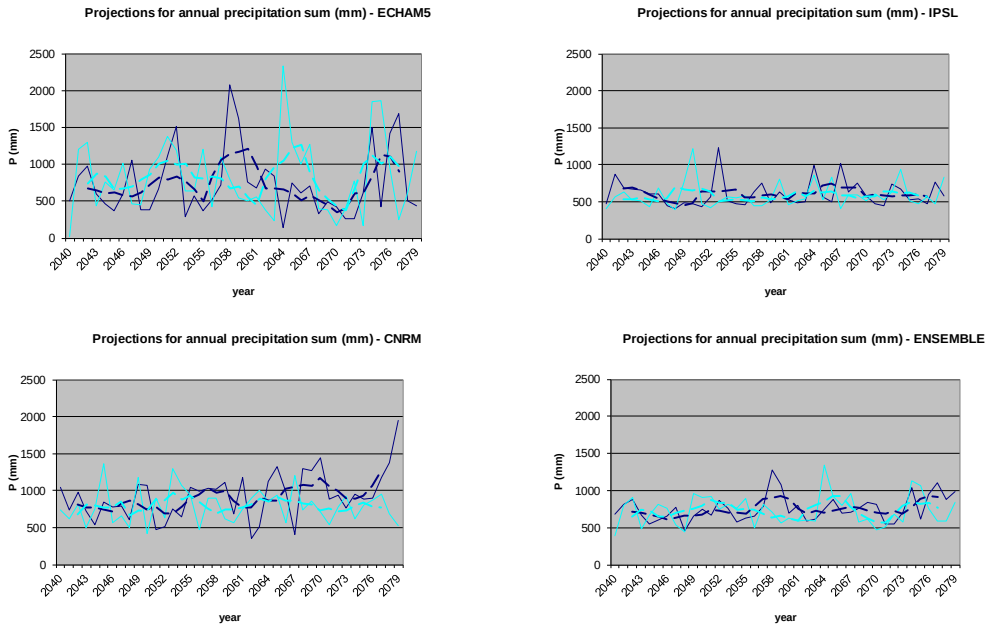


Figure 5: Projections of precipitation at Udaipur for ECHAM (upper left), IPSL (upper right), CNRM (lower left), ensemble of models (lower right). Blue: A2 scenario (dashed: moving average of 5 years), light green: B1 scenario (dashed: moving average of 5 years)

COUNT(2040-2060)	EC_A2	CNRM_A2	IPSL_A2	EC_B1	CNRM_B1	IPSL_B1
p>50 mm	60	69	6	56	66	3
p > 100 mm	6	13	0	5	18	0
p > 150 mm	0	1	0	2	4	0
COUNT(2060-2080)	EC_A2	CNRM_A2	IPSL_A2	EC_ B1	CNRM_B1	IPSL_B1
p>50 mm	47	91	4	62	39	5
p > 100 mm	4	20	0	3	8	2
p > 150 mm	1	5	0	0	2	1

Table 3: Projections of count of certain precipitation events at Udaipur for all three climate models and two emission scenarios

Figure 5 shows the climate projections for annual precipitation at Udaipur. There is a large difference between the models with the ECHAM model showing years with annual rainfall sums exceeding 1500 mm. Overall it is hard to distinguish a trend in the rainfall. Only the A2 scenario
in the CNRM simulation shows a clear rising trend in annual precipitation. The extreme events are not really visible in these graphs and therefore Table 3 is designed. This table shows the

occurrence of a certain event per day in the climate projections. We have defined a daily rainfall sums of at least 50 mm as an extreme event. The period of 2040-2080 is split in two parts to show if a change is observed in the extreme events. We can conclude from this table that only one scenario (CNRM_A2) show a significant increase in extreme events. The other scenarios show no change or even a decrease in extreme events. In this analysis we also see a different in the various models that are being used in this study. The IPSL model shows the lowest annual sums of precipitation and also has a low count of extreme events.

A concluding remark has to be made about recent developments in the climate model. As pointed out earlier GCM's are still running on coarse resolution. Recently, climate models are being developed which can run on a finer resolution (~0.25°) for a specific region. Within the EU-funded projects WATCH and Highnoon these, so-called, Regional Climate Models are run for the Indian subcontinent. As the spatial resolution is much smaller distinct features can be seen in the results resulting from, for example, topography or land-use. Figure xx shows the preliminary results of these developments. These pictures show the precipitation change in the monsoon season (June – September) between present climate and future climate. It shows that from 2011-2040 the area around Udaipur tends to become wetter than present climate, but that from 2041 on it will only become drier by almost 75% of the current precipitation at the end of the 21st century.

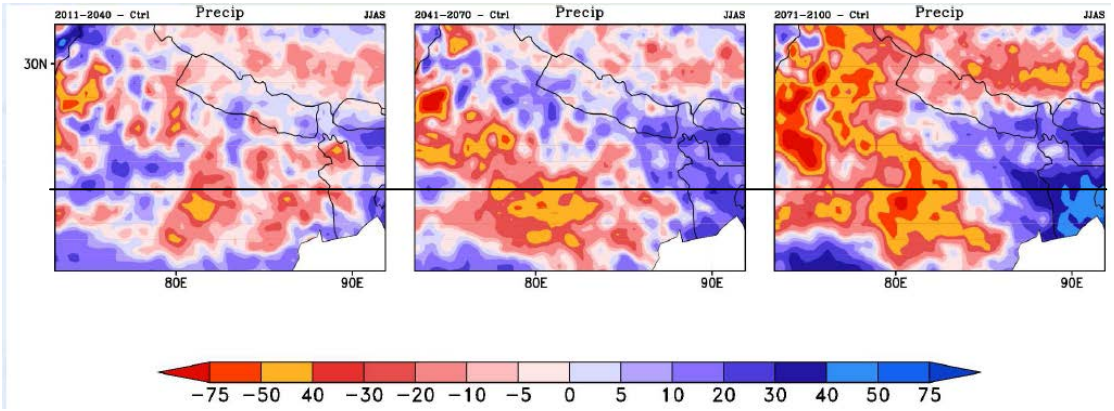


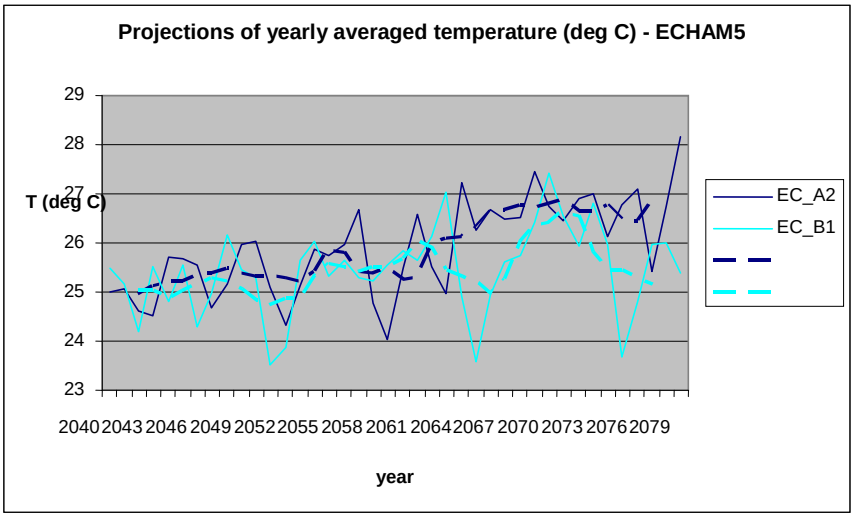
Figure xx: Results of the simulation of precipitation from REMO (regional climate model) displaying the percentual difference in precipitation between present day climate and 2011-2040 (left), 2041-2070 (middle) and 2071-2100 (right).

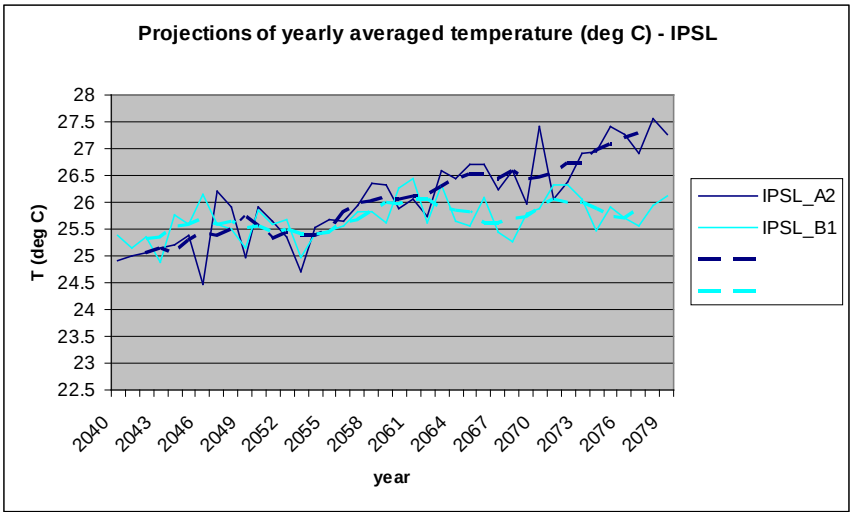
Conclusions and Recommendations on Climate Projections

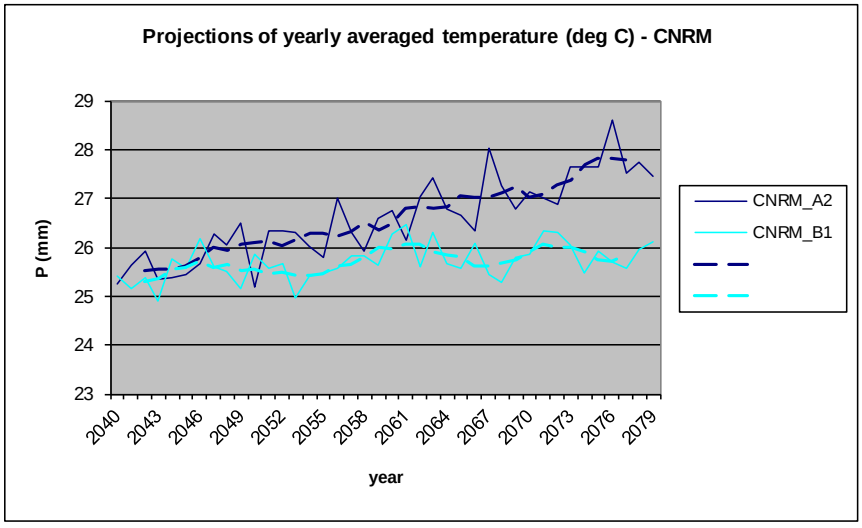
The temperature show for all models a rising trend for both emission scenarios although the increase in the A2 scenario towards the end of the period of investigation is much higher. What is also clearly seen in the climate projections for precipitation is that the ECHAM model shows a lot of variability in the projections. Based on the data available at this moment we can conclude that it is likely that the temperature will rise, but that the magnitude of this increase is dependent on the emission scenario. The precipitation projections are more difficult to interpret, but overall we may expect a decrease in extreme events while the yearly precipitation sums do increase slightly. Only one emission scenario and one model is simulating an increase in extreme events. Based on these findings we conclude that rainfall will fall over a longer period leading to a longer monsoon period. Some climate projections confirmed this hypothesis, but more analyses are actually needed to confirm this.
The validation of the climate projections was performed with the available observational data. This comparison was not conclusive about the performance of the climate models for the Rajasthan area. The climate projections which were used in this study originates from the EU-WATCH project. Within this project the climate models are bias corrected using the aforementioned CRU dataset. It is expected that the comparison between CRU and the models is better than the results presented in this study. CRU is an observational dataset which combines various datasets (e.g. ground stations, satellite data) on a 0.5° x 0.5° grid. This is a different spatial extend than can be expected from only one observational site (Udaipur or Jhadol in this study). One solution to overcome this is to do a bias correction directly on the observations from Udaipur and Jhadol. Although this is not straightforward and will need experts from the climate field, it will bring the climate scenarios to the local level that is observed.
As the models have their own dynamics it is hard to assess a climate projection on its own without taking note of the other models. It would therefore be wise to include as much climate projections as are available. From the EU-WATCH project the bias-corrected output from the GCMs presented in this report are available. The next step in the evolution of climate projections is the generation of Regional Climate Model projections. These projections are made with a Regional Climate Model (see figure 6 as example). These models are driven with output from a GCM at the boundaries. As their resolution is finer than a GCM it will give more regional detailed information. It is expected that the Fifth Assessment Report of the IPCC (AR5) will include more climate projections generated with these models. As more detailed information is available the hypothesis is that this will generate more realistic climate projections. Another positive point is that the climate projection will also be more tailored to the needs of users at a more local level. One of the disadvantages presented in this study is that the climate projections are still based on the coarse output which is generated by a GCM. However, it is the best that is out there at the moment.

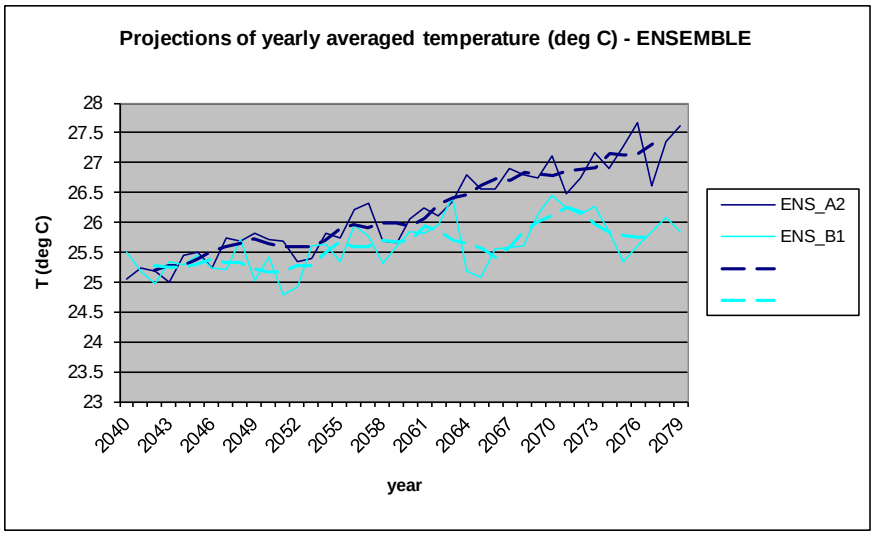
Data JHADOL

Yearly averaged temperature (º C)

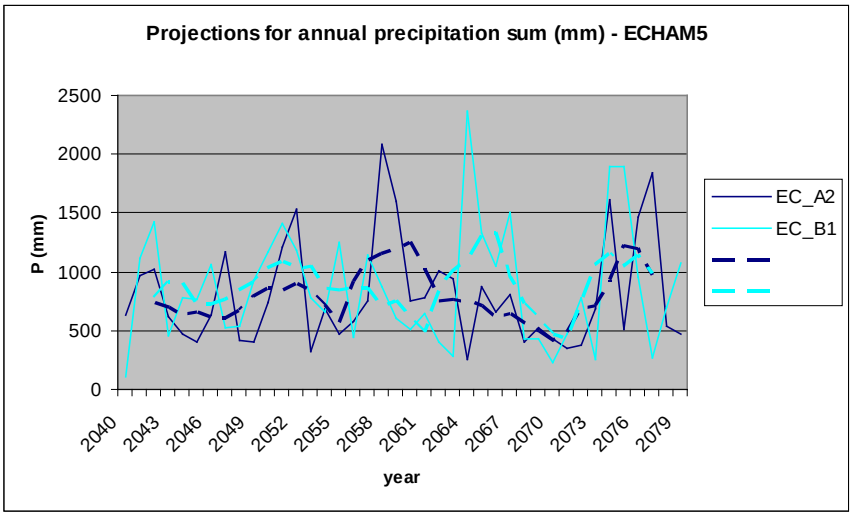


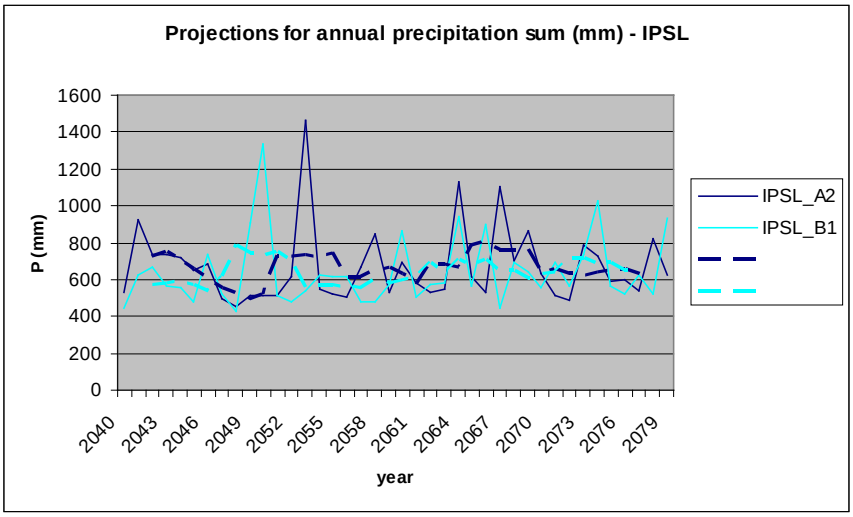


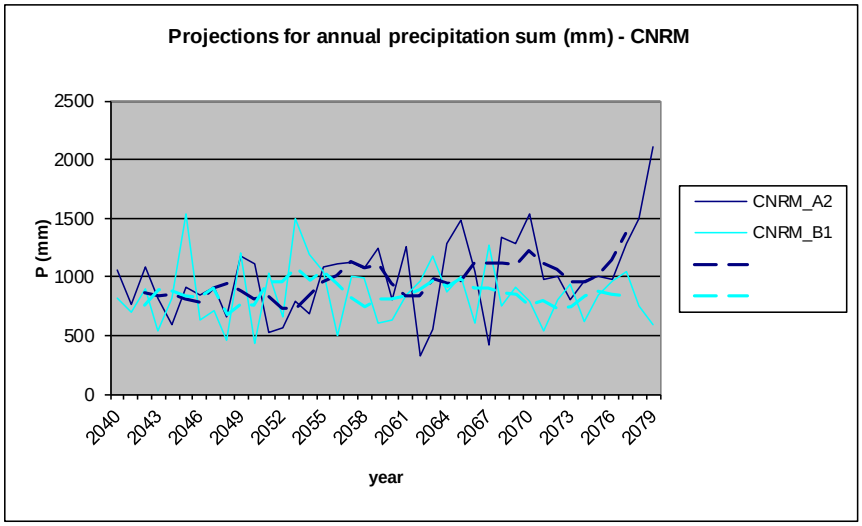


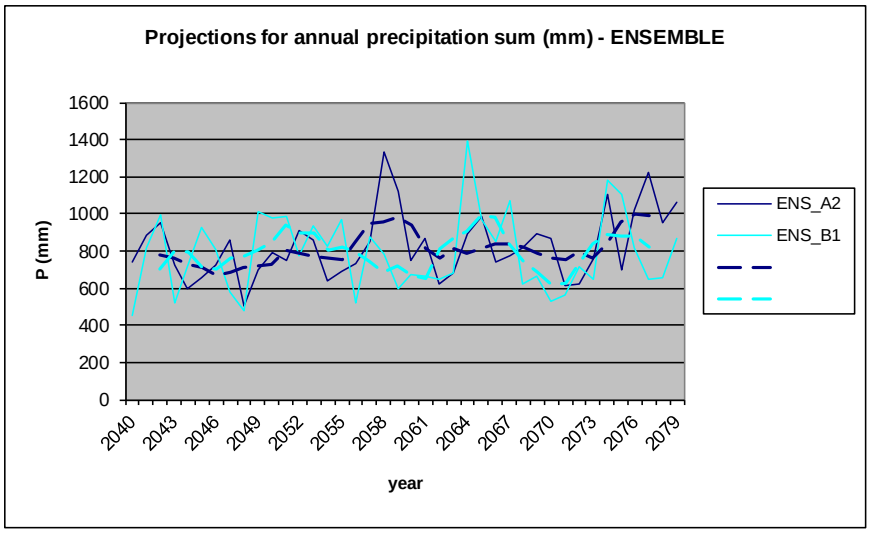

Projections of yearly averaged temperature (deg C) - ENSEMBLE
T (deg C)
28
27.5
27
26.5
26
25.5
25
24.5
24
23.5
23
2040
2043
2046
2049
2052
2055
2058
2061
2064
2067
2070
2073
2076
2079
year
ENS_A2
ENS_B1

Precipitation (mm/year)








Projections for annual precipitation sum (mm) - ENSEMBLE
P (mm)
1600
1400
1200
1000
800
600
400
200
0
2040
2043
2046
2049
2052
2055
2058
2061
2064
2067
2070
2073
2076
2079
year
ENS_A2
ENS_B1

Annex 4 Reports on field visits

Kherwara Block

KHERWARA OFFICE , Kherwara Tehsil
1ste round, august 27
Wasim.(head), Denash (NR), Dhaneswar (institutions: 119 in Kherwara)
Meteostation on hill near damsite irrigation department.

General climate impacts:
Less rainfall in the last 3 years. 2nd crop (Gram, Mustard) less production in last 3 years because less water in root zone. Less variability of products because only a few can stand drought; less waste lands because more under cultivation by introduction HYV.
Increasing heath is noticeable. Governmental Work Programme (NREGA: National Rural Employment Guarantee Act) implemented through the District Rural Development Agency provides 100 rph per family for 100 days/yr = 10,000 per year max as social minimum. Work relaxation from 30 to 60% hours per day because the too high temperatures in last May-June period.
Rich people can better adapt than the poor as they operate in closed circuits.
All sectors come together in one village; CC is influencing a few, but other sectors also change and influence village situation.
In this period of cotton cross pollination many people including young girls go to Gujarat. Some alternative development is provided by Evergreenrevolution of M.S. Swaminathan Research Foundation in Chennai, India.

GADUNIA (panchayat: Babri)
Coordinates: N ,E
Gadunia village comes under Kherwara block. It is 130 km away from main city Udaipur and at a distance of 40 km from Kherwara town (main road). The village consists of 5 hamlets and around 180 families reside here. The main occupation of villagers here is agriculture; the effect of migration is prominent. People used to migrate to nearby cities in Gujarat, like Ahmedabad, Himmatnagar, Iddar, Kadikalol. They mostly engage themselves into work like construction worker, daily wage labor as a harvester of crops like wheat, peanut, ber etc. Cotton market attracts mostly these villagers as they can earn more as compared to other works. The main crop for the villagers during kharif season is Maize, Pigeon pea, black gram, turmeric, ginger whereas during Rabi season they mainly go for Wheat, Bengal gram, Mustard + (rice in small areas).

1ste visit August 27
Present: 7 man, 3 ladies; Jaluram (agriculture, key farmer) leads. At the court of Jalurams house.
Long history with Seva Mandir: in 70th: adult education, in 80th planting, environment, in 90th organisations; waste land privately occupied became pooled plantation.
Many small dams with support of NREGA (rural income generation), irrigation department, Seva Mandir and others.
In last 3 years 11 boreholes for cotton, water level in open wells has become less. Land consolidation improved village water situation; less problems than neighbouring villages, which need water tanks by car.
Inter seasonal variability is noted.

Winters too warm/late (march) as wheat need cold temperatures (milky stage);
Maize is most sensitive for wet feet and moisture which causes diseases; this year already many rains and cloudy days.

Other developments:
Institutional cooperation is important to make a stand and have access to public money for the village. Link needed with agency and government support.
Need for monsoon prediction concerning time and amounts of rainfall so cropping pattern can be adjusted in time.

GADUNIA 2nd visit September 1
Ronak, Bidisha, Fons, Kannaiyala (SM Kherwara, agriculture)

Excursion (12:00) 4 women stay, 16 men join.
Dam site (2004: 3m high and 10 m wide) with pump for irrigation, drinking water (5-8 families) and recharge of wells. Available for village drinking water of more families from early June (no irrigation than). Last year empty in dry season, no irrigation possible, even loss of nursery. If reservoir is full than sufficient for 1 year drinking and 2 seasons 1 ha irrigation of 1 ha. Last 3 year practically dry and only irrigation in wet season.

Well (private) nearby with diesel pump (before it was a Persian wheel). Well is essential for irrigation and is used by neighbors for drinking water of families hamlet if other wells are dry and irrigation was stopped. In 2009 still irrigation of 3rd crop, in 2010 not. Discussion on scenarios: If 6 years low rainfall than no irrigation and priority on drinking water. No crops in winter.

Back in house Jhaluram (SM village committee) present 10 women, 16 men, 4 staff Seva Mandir. Still some CC impacts:
New cross-breads of buffalo give less milk production (minus 4-5 l/day) because sensitive to fodder: now less waste land because population pressure; jungle is fenced so less grazing lands.
Pre-mature delivery of goats because heat with small offspring small. Mother goat vulnerable to die. Goats mate at add odd times. Some skin diseases. No action yet.
In households more malaria, skin diseases and anemia with children and strokes with 40 year old men.
Flowering mango one month earlier and taste changed. Also custard, apple, mahua, timru..
Old Mal crop (30 to 35 years back) stopped as forests reduced ('mal' was grown in patches between trees in forests where dry leaves of trees provided the manure). Also, with population increase and less landholding, difficult to take traditional crops.

Other drivers:
Consumption: change in consumption pattern like mobile phone and some have need a fan as result of climate change (not in traditional houses)
Farmers priority is in agriculture to earn enough from farming and livestock.
Dilemma for agriculture versus livestock: both need land. If goats remain on stable, more crops are possible which gives fodder. If farmers plant cotton for income, this gives no fodder for animals and less fertilizer. Goats need the waste and forest lands

Concluding the above discussion a scenario was presented on the possible climate 15 to 20 years from now: temperature goes up; longer dry spells, possible 3-4 dry years, one year

heavy rainfall; heavy downpours, wind and rain will damage crops; soil erosion; water availability will go down because less options for additional storage. How the community could anticipate on these changes, was discussed in specialized working groups:

14:15: Work groups

1. agricultures and livestock, stable, waste land
2. homeyard: health and drinking water (women)
3. forest, soil and water conservation

Report back from the group discussions on measures:

1 Agriculture group

Strategies:

- Fertility cycle to be maintained, importance of fruit trees. Proper rotation of crops during the season remains important for moisture and fertility.
- Prediction of the character of coming monsoon by Pune Climate Service at district level or geophysical zone; Proper variety then can be sown. Natural indicators for weather predictions are not reliable anymore. Actual predictions at national level are not relevant; should be more regionalized.
- Activate seed bank, old crop varieties (30-35 years ago) will be included as more resistant against variable rainfall and tasted better.
- In agriculture change from cotton to oil seeds, pulses, gram. Wheat other variety allowing high winter temperature. Seva Mandir introduced 2 varieties: Lok 1 stands high temperature and needs less water. Ambrito need less water but low yield if high winter temperature.
- Because climate variability better do not specialize too much but integrate farming and rotate; introduction new fruit trees on damaged land; mix farming at more levels. HYV varieties like BT Cotton (genetically modified cotton). give higher yield and income, which is important given the smaller plot size. Jawar (a kind of minor millet) was grown earlier- it can be cultivated once again as it can withstand in less rainfall.

2. Homeyard (women group)

Impacts :

In 2010 well was dry for 3 months. Now need to walk 10 km to other hamlet, also for the cattle. Water tank comes to the hamlet every two days free of charge. Other hamlets (fala) are better off. In the village only 2 wells always have water. (total 55 wells for 135 families, 12 wells are better). People don't wash their cloths.

Health of mother and child suffers from heat. In the past the forest provided medicine.

The best wells are close to dams (anikuts). Restoration forest is not possible because droughts in summer. People generally get tired soon because of heat.

Girls, boys and men leave the village for cross-fertilization in the cotton in Gujarat during 2-3 months August, September, October. Hard life and nutrition is less.

Strategies:

- Kitchengarden; priority for fruit trees; they select less sensitive varieties; collect roof water for the garden.
- Anicut dams (low wide dam of flat stones) can be useful to increase water availability.

3. Water (Pani) and forest group

Strategies:

- Small and big anicuts (dams) should be built based on requirements and locations. They will help to store more water that can be useful (i) to cultivate vegetables (ii)

meet drinking water needs (iii) give water to plants (iv) irrigate cotton crops after October month (v) in vermi-compost beds.

- More and multipurpose trees should be planted to overcome periods of droughts. Plantation should also be done on forestlands.
- Plants can be also be grown on farm-bunds. Trees like Subabool, Neem, Ber, Custard apple, Lemon, Mahua etc. can be useful in changing climate as they can withstand high temperature.
- Strong rules should be available to conserve forests.
- Breeds of cows, buffaloes and goats should be local as more resistant and remain quality.
- Crucial wells should be protected. Collective decisions for priorities on different uses of the water like drinking water and agriculture mainly, even if private well.

Lessons learnt

- Good meeting as for all participants there was something new like linking the CC impacts with measures and putting priorities; formulate aspiration; define opportunities like pearls of the basin.
- Discuss future climate impacts during the excursion in the field at the hotspots sites is effective.
- Give specific assignments for the group discussion and repeat the climate change extremes
- Important to have focus groups, especially for the women. This gives new information and possible future support.

Closing: village committee to pick-up on work on with the conclusions and SM comes back in September/ October for follow-up.

NICHLA TALAB (low pond)

This village comes under Kherwara block. It is 125 km away from Udaipur city and is at a distance of 35 km from Kherwara town (main road). The village consists of 3 hamlets with 200 families residing here. Being situated at hilly region the people here face the problem of low rainfall. The main occupation of the people here is agriculture and most of them do rainfed farming. Recently watershed development activity has been undertaken in this village whose result is yet to be witnessed by the villagers. Migration effect is less here as people find work in their village itself of like engaging themselves in NREGA scheme or working as a wage labour in pond digging task, as a brick maker etc.

Seva Mandir later involvement: less institutions; in 90th education, after droughts period a small soil & water programme was started.

1st meeting, august 28

4-5 man and 10 women (2 active) President Hadzim has 25 years of experience. Location at school overviewing valley with temple on elevation and many (artificial) pounds.

Mainly rainfed agriculture: 1st crop maize /rice; 2nd crop patches of mustard; 3th crop few

Rice is planted in streambeds in strokes progressively once terraces fall dry.

Impacts: 1985-86 very dry period; recently for 2nd crop failed because less rain in monsoon

Groundwater levels fill up later and disappears sooner.

Drinking water: 3 permanent open wells+ in monsoon many more at 1 km distance.

Main pond always (25/10yrs) full in monsoon. Once in 3 year dry during last 10 years because less rainfall, like last may/june (djalar season).
Other villages have less problems in areas because SM soil water programme.
Onset of winter is delayed from December to January. Winter with temp till 4 degrees is decreased from 4 to 2,5 months so insufficient milky stage and low production wheat.
Other drivers:
Wage labor migrate to Gujarat 2-3 months but lass than people in Gadunia. Much work on the roads (NREGA) is providing additional income.
Population growth causes less waste land resulting in less vegetables, poor variety of food;
..and decrease of livestock.
There is a change in consumption pattern; cash earning and spending has gone up. Families are spending on items they think are important investments: mobiles, motorbikes etc.
Market (government) influence of the use of HYV. Very clear is the increase of HYV and the use of fertilizers in last few years in many villages. It certainly reduced the biodiversity in agriculture and the traditional crops like small millets which are more nutritive are now grown less. Their resilience to climate variation is also less as they are meant for growing in particular conditions.

Lessons learnt: Follow a clear sequence: (1) activities and economy; (2) effect of climate change and other drivers; (3) possible measures; (4) how to deal with longer term CC giving more variability and more extremes and (5) what are the concerns.

NICHLA TALAB
2nd meeting, 2 September
Ronak, Bidisha, Fons, Bawalwara (zone officer)

Excursion 3 farmers join.
Tubewell (10 years old): site selected by local expert. Now electrical pump, water at 195 feet deep, daily half an hour water then empty during that day but during the whole year. There are 4 more wells in the area with the same productivity.

> *The total capacity of bore-holes has to be in line with the storage capacity and infiltration (area). Thus it is important to understand groundwater system as common resources and develop a community-based management system.*

Open well at 20 ft deep, This year 2010 has a strong monsoon which facilitate irrigation. In 2008 and 2009 no irrigation only drinking water. Vegetables in only during monsoon.
Wheat very little priority. This year coming Rabi wheat trial with 3 irrigations on soil water parallel with gram and mustard to assure any harvest. During 3rd crop (Zaid) there is no irrigation and people go to Gujarat for income.
Open well (40ft deep) keeps water longer than pond nearby (10ft deep) but also dry in Zaid 2010.
Issues: community depend drinking water, washing, social, cattle) on pond and open well nearby temple.
Dilemma: available waste land for livestock.

Meeting 15 men and 6 women on veranda of school. Gavri dance in off-season in neighbouring village, so less presence.
Introduction on results 1st meeting concerning CC effects and impacts and threats of climate change in future.
Scenario: trend 15-20 years from now: temperature goes up; longer dry spells, possible 3-4 dry years, one year heavy rainfall; heavy downpours, wind and rain will damage crops; soil erosion; water availability will go down because less options for additional storage.

What may be expected?
Rice suffers if high temperature and less rains. Wheat will not survive, Maize, mustard and gram my stay. Higher wind and rain affects grain crops more frequently during the last 10 years. Cotton is not possible because shallow soils and less water.
Not much livestock: buffalo's and 2-3 goats per family for milk and manure. Fodder feeding is possible. Difficult breathing all animals because higher temperatures (possibly).
How to anticipate on scenario?
Discussion in two groups: Women group (5) and a men group (10)

Reporting back plenary on measures:

Homeyard group:
Impacts:
There are wells with drinking water in the hamlet. Last two summers they dried up and women had to walk over 2-3 km to other hamlet. Effect of newly built damsite (anekut) 3 years ago was noticeable only this years as previous 2 years not were dry. Women collect water for drinking, livestock and vegetables at the homeyard. Women also collect straw for livestock (men also). Mortality rate women has increased possibly by higher temperatures.
Other drivers
Migration to Gujarut not good but necessary for cash money. Education important but considered less important than hunger and cash. Maybe men stay if there is enough water for 2nd and 3rd crop
Diseases in families have increased since a few years. Improved health facilities because better services, besides local herbs. Population density is not seen as a problem as long as there are 2 sons (daughters not counted).
Strategy

- Priority strategy: Protection area around well minimal one for each hamlet. If possible more wells.
- Present houses become hot in summer. Efforts will have to be made to make the surroundings cooler.

Agriculture, water group

Dilemma: with CC scenario under existing resource conditions, the systems of rice, wheat and buffalo will reach to a collapse in the village. In that situation, how will you survive and how can that situation avoided?

- Both agriculture and livestock are essential for livelihood of dwellers, and have to be survived. better predictions of monsoon.
- Find other buffalo's to survive
- Irrigation requirements are to be met but storage of water is difficult in village due to terrain and current landuse;
- Adjust crop selection, while gram, mustard and maize will be less effected. Consider rainfed rice in dry year monsoons; Characteristics of monsoon to be predicted.
- Trees can overcome dry spells better than crops. Plantation of more trees is difficult in fields. Species that can provide fruits and other produces are better for plantation. Fruit trees on slopes, grains in valley. Trees as additional income and double function for fruits and fence around farmyard;
- Identify the groundwater aquifers, (e.g. the handpump near the school does not dry fully even during dry periods), and efforts should be made to protect and recharge them; Protection of resources by reduction of run-off and increased infiltration to the groundwater.

- Only 4 tubewells provided drinking water to the residents during the last summer. Increase of use of borewells and less supply of water can further hamper availability of community water. How to balance between private and communal use of water?
- Village pond can be filled in future by making a canal from the dam located in the neighbouring village- Kanpur.
- Opportunity climate change: higher T may result in new fruits. Visit areas with T2+ areas to learn how to manage.

Lessons learnt?

- Underground water systems are little understood but essential for drinking water and seasonal water storage.
- More remote areas are deprived from market opportunities and innovations and suffer from higher costs;
- Using strong village institutions (samuhs) makes it easier to talk about future impacts and strategies to develop.

Jhadol Block

Jhadol block office Seva Mandir, Jhadol Tehsil
Kripa Shanker Joshi (head of Jhadol block); Devilal katara (NRM); Samrath Singh (NRM-forestry, Udaipur); Sabjiram (agriculture); SM Udaipur Bidisha (energy, cookstoves,), Arun (NRM)

DHALA

Dhala village comes under Jhadol block. It is 80 Km away from the city Udaipur. It is considered as one of the important village in SevaMandir work area as lots of activities have been undertaken here. Total no of families here is 301 residing in 5 hamlets.The main occupation of people here is agriculture. The effect of migration is less though few migrate to the city Udaipur and engage themselves in activities like wage labor, rickshaw puller etc. The main crop for the villagers during kharif season is Maize, Pigeon pea, black gram, turmeric, ginger whereas during Rabi season they mainly go for Wheat, Bengal gram, Mustard + (rice in small areas).

Dhala is an active village with many Seva Mandir activities:
5 hamlets 350 households; Many Seva Mandir activities through village development commission: forest on 25 ha new land, organic fertilizer, seed bank, monitoring, pre-nursery, birth attendance,. New: groundwater management with monitoring well depth; 3 crops a year: maize, mustard, vegetables (irrigated); cattle: goats, buffalos, pumps for some irrigation.

Dhala 1st visit august 28
Location higher situated terrace school building overlooking the valley (some rain).
Present: 31 = 3 women, 28 men. Kalalal (NRM volunteer of SM group since 1986 →25 yrs); Ramji (VDC); Sasira Menah (Horticulture, organic fertilizer, surveyors (3 students from Bombay); The historical knowledge of the villagers goes back for 21 years: before full forest, rich millet as 1st crop, 1-2 2nd crops.

Observed climate changes
Winter becomes shorter: was 5 months (oct-mar) but is now 4 months (nov febr)
Monsoon shorter: from mid may-sept (4m) now july – august (2,5 months)

Main monsoon (strong) from SW (Arabian sea) The last month of monsoon is the back monsoon and more regular from SE (Bengal Sea). Main monsoon is more extreme.

CC Impacts
Heat causes dehydration of children and elderly people
Rainfall less results on less water for crop: before sheep were on paddy field
Maize before on slope now only in the plain for more water in rootzone needed.
Water for drinking sufficient, always water in reach by hand pumps.
For irrigation not sufficient water for Rabi crop.
Rainfall intensity: Before small rains during 10-20 days and clear days in between
Now Showers of 3 hours with local variation and more dry and warm days.
Because cloudy weather and rainfall maize corn can not grow well; much fodder.

Other drivers
More population need more fuel by cutting of trees (not for people from outside). No regeneration because cattle grazing and therefore less products like herbs, less hunting, more water loss (erosion is not mentioned but visible after a shower).
Market price for some grains like millet is not interesting. However millet stands water shortage.

Possible measures
Use varieties of grain which require less water. Make more use of ponds and water storage (in soil). Change form forest and soil conservation to integrated soil and water management and commercialize biodiversity

Dhala 2nd visit, Friday September 3 (Ronak, Bidisha, Fons)
Excursion with 4 people and key farmer, house with open well, mix of traditional maize and HYV maize, mixed cropping, incl commercial crops, maize suffers lack of drainage and clear river erosion and protection works by farmers. In valley high agricultural potential. Slopes are sensitive to erosion.

Meeting (late) at community center/ prae-nursery school.
Present 26 farmers, 6 ladies and 2 students, 3 SM local staff

Scenario for the region:
Trend for 15-20 years from now: temperature goes up with 1 degree and 2 degree in 30 to 60 years; Monsoon could change, high variability in rainfall between years, and number of dry years possible 3-4 dry years, one year high rainfall; heavy downpours and long dry-spells between two rains, Humidity will go up with more heat; Increase of winds and turbulence.
This climate change is likely to happen? What are the future? Or is lower ambition level required?
Possible climate impacts already have been observed. Wind and rain will damage crops; soil erosion; water availability will go down because less options for additional storage.
High temperature and humidity will affect maize, wheat and rice crops. crops requiring more water could not be cultivated; due to dry spells seed germination will be problematic; second and third crop will be difficult; goat will survive- need of more grazing land or fodder; Human health- more incidence of dehydration, difficult to work requiring physical labour.
This scenario was presented by the team and was considered as very likely to happen by the meeting also during the group discussions on homeyard, agriculture and soil and natural resources..

Women group:
Conditions:
Health has become better because of organic food (less use of fertilizers and pesticides)
Firewood is needed and trees are cut for local use. Fruit trees are better maintained and not cut because fruits are needed. Population pressure: no problem. Average 2 sons; girls are not counted. Water is always available with well at 2-3 km or tanker facility by Sarpanch. Goat keeping require less water.
Migration: first try in Udaipur in lean season. If no work then to Gujarat. Money from work used for buying essentials like food, clothing
Strategies:

- Fuelwood is available now but with climate projections, it could be difficult. Households will continue to cut trees but if fruit trees are planted, the cutting could be lesser. Tress wood be planted around the homeyard.
- Members go to Udaipur for work, and even to Gujarat if required. Will need to go more in future if become difficult to survive in the village because of climate change.
- Livestock: goat should be kept as buffaloes and cows need more water and poultry also need more feed and water. Provision has to be made for drinking water of livestock. Roof-top rainwater harvesting can be a solution.

Agriculture strategy:

- With less water, the production in agriculture will go down, so farmers will have to take crops that require less irrigation
- For more intensive downpours better plant maize on the slope land and rice in the plain.
- Predictions of the monsoon are important; for longer wet monsoons irrigated winter crop becomes more important.
- Some (safe) measures will be needed against insects which are attracted by humid warm weather conditions.
- Protection of forests is essential- one should plant fruit trees for more income. Bamboo plantation is useful. Protected grazing should be possible.
- Vegetable cultivation can be increased to earn better income.
- Cultivate crops, like batti, kangni, mal (old varieties), that can survive in more rain.
- Plant trees that can withstand high temperature. Trees can be planted on farm bunds to avoid erosion.

Water strategy:

- Store more water through construction of anicuts and checkdams, for recharge of wells; community dams only 2 m high, not enough.
- Community wells, providing water for 20 to 25 families, can be allocated and protected for drinking water.
- Soil and water conservation activities- farm bunding, checkdams, anicuts etc., can be an important strategy to save more water.
- Better irrigation facilities can help farmers to compensate the loss of monsoon crops during high rain. Farmers can even take two crops in winter with early harvesting of monsoon crop.

Lessons learnt:

- The role of key farmers is important for introducing innovations as well as understanding on CC impacts, scenarios and strategies.
- Field visit gave evidence of increasing erosion, which is seldom mentioned as an issue.

Dhala : 3rd visit November 1

In follow-up of the first two meetings on climate change a 3rd meeting was implemented to see how far the community had integrated the results of previous meetings. The meeting in Dhala village was held on November 1, 2010 at the community centre. Around 15 male and 5 women participated in the meeting. Arun Poojary was present of the Seva Mandir climate team. Meeting started with the recap of previous two meetings held and briefing the purpose of the current meeting.

The following CC related activities were discussed for planning purposes to be integrated in implementation plans in 2011 and further.

Soil and water

- Treatment and protection of 116 ha of forest land which is currently open for grazing.
- Soil and water conservation activities to be taken up in the rest of the village where watershed development activity has not taken up.
- Series of check dams in the small streams flowing from forest land and construction of two anicuts to harvest rainwater which help in increase in water level rise in wells and subsequently lead to summer crops. Series of check dams help in collection of sediments and lead to collection of water in anicuts.
- Well recharge through the construction of check dams and percolation tanks near the wells and channeling of filtered water to open wells.
- Plantation of combination of different species plants such as teak and bamboo on the farm bunds exist in the village where watershed work had undertaken.
- Roof water harvesting structures in majority of households in the village should be undertaken. Two such units are already exist in the village which was done during watershed development work as pilot and water stored during the rainy season is being used for next two to three months for livestock and household chores.

Agriculture

- Development of community lift irrigation system to ensure a minimum irrigation facilities. Four such systems could be placed in different hamlets of the village covering around 50 farmers.
- Promotion of vegetable cultivation in the form of kitchen garden and large scale farming with the farmers with good access to irrigation facilities
- Seed banks with all variety and seasons seeds should be continued. Seed collection for the seed bank should be centralized (seed collection from one standard and good field) to maintain quality of seeds stored.
- Usage of improved variety of seeds which are suitable for climatic variations such as drought resistant variety of corn and low irrigation wheat.

Livestock

- Introduction of improved variety of goats and bullock for cross breeding
- Cattle camps should be organized twice a year before the onset of seasonal diseases.

As can be derived from the text most of the measures were not new to the farmers but got priority in the programme as resilience to climate change. Further integration with other Seva Mandir activities will be required in the beginning of 2011.

SOM village
450 hh in 5 hamlets700 ha thick forest (moa flower) source of Soon to Mahari river
GPS N 240 10'979; E 073 20'484, level 570
Som village also comes under Jhadol block. It is an historical hunting area and 110 km away from Udaipur. The main occupation here also is agriculture. Migration effect is less and people mostly migrate to city Udaipur and equally to Gujarat. The main crop for the villagers during Kharif season is Maize, Pigeon pea, black gram, turmeric, ginger whereas during Rabi season they mainly go for Wheat, Bengal gram, Mustard + (rice in small areas).

Seva Mandir activities are the use of waste grounds and introduction of lift irrigation, (15/20 farmers), village forest land 65 ha and new plantation 45 ha+ first ownership than S_W conservation than plantation+ people by wood from far away, youth research (10 17 years, recreation and problems), 2 non-formal education, prea-nursery

1st meeting 28 august
Present 26 men and 1 lady; Liyu Karini (head village development committee also at district level) Stadiki (lady) Mahlilat (agricult), Bimrachi (secr), Bidilat.

CC impacts
Based on observations over 20 years, during the last 5 years temperature went up, humidity days increases, winter is becoming warmer. Monsoon from 4 to 2,5 months (15 June to 15 Nov becomes 15 Jul to Aug) and also less and erratic rainfall. Always variability of rain but now more intensive. Different rain regimes from regular toward in time and spatial fragmented; up to one month gap after the first monsoon rain.

Some effects and impacts
Reduction of groundwater level. Som river dies already in summer before end rainy season; Higher humidity and temperature cause diseases resulting in lower maize production.
New (other) insects since 10 years; Bats colony (100)died in house in one night last June (very hot); Livestock diseases but also possibly from fertilizer and insecticides.

Other drivers
Population growth ask for more farmland and leaves less space for livestock grazing on waste lands.

Possible measures
Forestation with different species; Harvesting rain water; Integrated soil and water management programme (not only conservation); Develop own appropriate techniques (tailor-made); More organic agriculture from and for livestock; Community based irrigation system; Importance of wheat as grain for food as it is cool in (hot) summer; maize is a warm food for winter time. Priority water for wheat however winter too warm so other variety is required.

SOM
2nd visit, September 5
Late arrival at governmental guesthouse because bridge was broken. Therefore excursion at the end. Bridge maintenance might be urgent as during excursion a bridge was indicated with concrete rot; iron visible.
Present: Men 26. SM staff from Udaipur 3, from zone 2. Gavry festival so no ladies.
Short summary of results 1st meeting and plenary scenario development on climate change and possible impacts.
Plenary session described some issues in the village.

- Drinking water was a major problem in past. People had to drink water from rivers. Now more there are wells and handpumps. Waterborne diseases decreased but availability of water till summer also reduced as droughts increased. Testing of drinking water indicated that content of salts in wells gone up This year more water flows down through river than before with no way to store it in reservoirs or groundwater.
- Livestock - total number of animals in the village gone down. Reduction in highest to lowest- cow, buffalo and goat. Presently, cows and buffaloes are stall fed and goats go for grazing. At present, animals are dying due to eating of grass contaminated by chemical fertilisers/ pesticides.
- Only Mahua as produce and wood for fuel is available from the forests.

Climate change impacts in future were presented. Overall annual average rainfall may go up but always with dry years in between. More incidences of intense rains with longer dry spells in between, difficult for seedlings to emerge. Temperature rise will pick up- warmer years, shorter winter, more diseases. Number of goats will rise but less cows and buffaloes. Humidity will rise with higher temperature under cloudy conditions causing high infestations of insects. Community will need to prepare for both dry and wet years. Prioritise strategies- home, home-yard, and environment

Following a group discussion in two: 1/ Agriculture and livestock; 2/ Forest land and soil and water conservation

1/ Agriculture and livestock;

Impacts

In future, with more cloud bursting/ intense- most crops of Kharif will be affected as water will get in the fields. For Rabi, rise in temp. in winter will start early than present which will result in drying of wheat. If oilseeds (mustard) will not grow, households will not have oil. Lack of water due to scarcity- fodder will not grow and animals could die. Less livestock means no compost hence no or less productive farming. Buffalos need less fodder than cows and already becomes more expensive. Dry years would be more critical as both monsoon and winter crops will fail. So, important question is that whether agriculture will sustain in those situation?

The future goal for the community to is have a sustainable agriculture to which can overcome wet and dry years

Strategies:

- Balance crop scheduling between monsoon and winter crop shall be more important under variable climate conditions: more 2nd crop in high rainy years. For this, water storage is most vital. Need more wells for irrigation but little labour and farmers are not able to invest in water conservation measures due to lack of money.
- For livestock conservation, promotion of local breeds coping climate change, can be encouraged so that organic fertiliser will be available for agriculture. In dry years less production, fodder is needed from storage.
- Selection of seed varieties for variable monsoon. Therefore seed bank needed. Traditional varieties of maize like malaan, santhi etc. can survive with less water. Today, these varieties are not used much. However, farmers if require can use them in varying seasons. Selection of varieties can be done based on time of rainfall.
- Wage labour will become more essential as risks and uncertainty in farming will increase. Rural income from government programmes and Seva Mandir projects. Being a historical hunting area, tourism was suggested by the team as source of income for the Som community.

2/ Forest land and soil and water conservation
Strategies:

- Summer is lengthening. Time for flowering and new leaves is getting delayed on average by around 1 month, but that is not constant each year.
- Som still has good village forest. It will have to be conserved so that benefits can compensate the agriculture losses. For example, Dhavda a local tree that provides Gum, is reducing. It can be conserved and income can be obtained.
- Streams flowing from forestlands will have to be checked so that water level in the wells will go up. Construct 3 to 4 anicuts on the main stream and irrigation can be done even directly from reservoirs. The reservoirs can be used even for fish farming.
- Bore well can be dug for drinking water on locations where enough water is available and that well can be protected. In dry year drinking water need priority; at least one good well per hamlet and preserve good.

17:00 Excursion:

1. Rice planted in riverbed is little managed no fertilizer or care for rice in riverbed.
2. Construction of dam sites is possible on bed rock in deep valley;
3. Wide plain available for irrigation from dam site. There might be a risk of temporary flooding.
4. Shadow prices of labour and seasonal migration was discussed

Som : 3rd visit

The follow-up meeting on climate change pilot research was held on 30th September 2010. Around 20 villagers participated in the meeting leaded by Arun Poojary. The purpose of the meeting was to select few possible interventions villagers perceive to be taken up in the village to counteract against the local effects of the climate change. Few of the activities spelled out are as follows:

- Series of water harvesting structure in the streams of forest land to store run-off water. Since the village has vast patch of forest land in the upper stream with less facility to harvest run-off water, developing series of water harvesting structures help in increase of water table in the low lying areas. Open well recharging systems are to be done to increase the water table of the area.
- Farm ponds are to be dug to collect run-off water to increase the water table as well as for cultivation of vegetables. Farm bund and check-dam activities should be undertaken in the whole village on the basis of watershed principle to prevent soil erosion and moisture retention till off season.
- Plantation of species of multiple use like fodder, fuel wood, fruits and timber should be planted on the farm bunds. Horticulture plants should be planted for diversifying the farming system where possible on bunds of the farmlands.
- Insurance of crops of Rabi and kharif season against the crop failure due to adverse climatic variations. Strengthening of seed bank to cover seeds of all variety and season crops
- Introduction of improved variety of goats and bullock for cross breeding. Cattle camps should be organized twice a year before the onset of seasonal diseases.
- Protection and development of another 50 ha of degraded forest land currently being open for grazing. Agro-forestry activity should be undertaken for maximization of land use with the combination of agriculture, horticulture and forestry plants. Since there are plenty of waste, uncultivated land lies in almost every patch of farm land, these lands could be used for planting forestry plants.

These activities are to be integrated in an implementation plan with funding for 2011 onwards.

Badgaon block

Chhali in Badgaon block Seva Mandir, Gogunda Tehsil
Meteostation in Gogunda, Manuch block coordinator lives at technical school which works closely together with Seva Mandir.

CHHALI is panchayat (more villages) SM 6 hamlets, 300 hh,
Level 770 m, coord N240.36'756 and E073 30'311
This village comes under Badgaon block and is only 45 km away from Udaipur. It consists of 4 hamlets with 200 families residing into this village. The main occupation of people here is agriculture but people here are now losing interest into this and engaging themselves into other occupation like working as wage labour, rickshaw puller into nearby city Udaipur. The main reason for people losing interest is due to regular loss of crop yield. People in all these villages mostly do rainfed agriculture and because of change in weather they are facing problems of failure in crops. Main crop is like maize, Pigeon pea, black gram, Wheat, Bengal gram.

Seva Mandir activities on agriculture, prae school, birth attendance, informal education, solar programme, watershed management, groundwater drinking water and sanitation.

1st meeting 29 august
Location under Benyan tree on big terrace beside temple.
45 men, 20 children and 5+4 women come later When question on health to women, no reaction but laughing. Later 2 smaller groups split off; maybe also for socializing (Sunday) or other meeting. During rain all people went into public part of temple house 3x6 m.
Block coordinator Manon, Zone coordinator: Phupendear Sharma, Ronak and Fons

CC effects and impacts
Rainfall: spatial differences, less rain during last 3 years. Special crops on the slope, seed with leaves in soil as mulch, do not survive drought. Before chilies were cultivated but disappeared because diseases. Last years no 3rd crop that needs groundwater for irrigation. To fetch drinking water groundwater level in hand pumps went gradually down from 1-2 m till 10 m. Normally no problems as soil and water conditions are better than other nearby villages.
Since 10 years no ice sheets anymore on water surfaces. Higher temperature results in reduced winter from 4 to 2 months. This decrease wheat production.
Health situation: small pox and worm in water under control but now malaria and dengue because temperature rise and humidity rise (clouds and wet surfaces). Increase mortality of Mango. Livestock no disease because of injections. Cows give less milk because quality of grains is low. Less waste lands so less grass and additional food from outside. Grass that do persist drought is hard and cause throat injuries.

Other drivers
After 1990 increased forest control with wood concessions to private, village could lease but villagers cut the trees for firewood and new lands for increased population.
Population pressure and drought: youngster migrate daily to Udaipur for additional family income (no trust for work in future in village, also there only daily labour work)
Ronak stresses that climate will continue to changes and asks to identify measures to cope with the climate effects. Next visit also visit potential CC affected area.

CHHALI 2nd visit September 4
Present from Udaipur office 3, block 1, zone 1

12:00 Excursion
Mountainous waste land of many private land owners, has been protected by soil and water conservations. Stone walls for borders and cattle roads. Incidental agriculture in depressions mainly for fodder once a year. Revenue area part on hill is bare and sensitive to erosion. Option for fenced protection for regeneration on contours is discussed.,
Some local dams with flat stones (SM, 2008), a concrete dam built by government and old earth dam with stones filled with sediment which functions as water break and infiltration for water storage while surface is used for agriculture. About 15 to 20 farmers profit from water conservation and reduction of flooding and erosion along the stream.
Total of livestock goats and cows went up; number of buffalos (traction) went down.

14:00 Meeting replaced to town under Neem tree close to Gavry festival place so people could better attend. Present 22 to 40 men, no women. After rain 15:30 meeting went on with 8 persons at village meeting centre till 16:00.
Scenario 15 years was presented. Higher temperatures which may affect health and wheat growth. Shorter winters and variable monsoon. Slightly more rain, more yearly variation with longer intervals and more intensive rains and more clouds. Less wheat, no rice only goats.
Which impacts? how are the consequences for community? Which measures?

Agriculture
- Strategies to switch crops and husbandry according the predictions. Need for local prediction of monsoon by Pune for choices between crops as local calendar is not correct anymore: predictions of type of seasons fails.
- Maize can continue to grow but less productive under too humid or too dry conditions and more varieties are needed and better field cultivation. Chilies can grow if warm. Millet is good but high labor and no market. Crops like sugarcane and rice can be taken up in years of heavy rains. Before farmers used to grow sugarcane in the area but got reduced with lack of water. But, they do have experience.

Soil and Water
- Store more water- dams of height till 2 m which is presently allowed by government is not useful for surface irrigation and need large size dams wherever feasible. Preferably built by the government as local labour is not available.
- Soil and water conservation measures which will have to be a continuous exercise to withstand the climatic variations will reduce by lack of labour and agriculture will be further affected.

Village economy
- Villagers will need to get more clarity on their vision of farming- commercial or subsistence? It will further help in deciding the strategy- convert more uncultivable lands to cultivable or encroach more common lands for meeting commercial agriculture needs of more children, or protect and continue with existing pockets of land and try to meet all household food needs from them.
- In future, the youths as they grow old will not be able to continue to earn from cities. But that time even if they returned to villages, will not be able to do farming as they have not learnt it.

- Migration is affecting soil and water conservation as people today are not able to make efforts for the measures. Trend started about 8-10 years back with youths going out to earn. They are now not able to give time and also become less interested as small land holding is enough to meet food and livelihood needs. Wage labours give land to neighbours under sharecropping (50/50) resulting in lower production.
- Same time, extra animals (goats) may be bought by wage-earners as insurance. Cattle increases with pressure on grazing land. For maintaining grazing land no labour for maintaining it. This results in lower livestock production and environmental degradation. Community is in a negative spindle.

Try to develop a new scenario: how to handle with less labor and saving the environment some financial support.

Annex 5 : Meeting with institutions Udaipur

Ronak Shah (Seva Mandir) and Fons Jaspers (Alterra-ICCO)

Department of Livestock

Monday September 30; Animal Husbandry Veterinary clinic (9460444490). Assistant Director Dr Jajendra Lodha, assistant director), head of the laboratory ( )
Over the district 73 branch offices and 133 observation centres; available at a distance from 5-15 km. Each village has a animal husbandry contact person.

Animals and bovines (the milk of) are most important for the daily menu along with grains and vegetables. In addition function or traction and rural bank. Depends also on nutrition value of grasses; stall feeding would be more efficient than grazing. Goats are also favoured as ATM (any time money/ milk): easy to transport, low value, low sentiments for selling like for cows;

Livestock is raising since 1950 (acc statistics). Villages information mentions less livestock; may be village reports less livestock per family.

CC impacts
Temperature: hot season increases and will ask energy of animal for cooling down. So becomes more tired in search of food and less resistant against diseases. Once too hot, difficult to bring temperature down. Early birth for 10 days results in weaker calf.
Goats are most adapted to high temperatures and hilly conditions of Udaipur but have a negative effect on vegetation (roots) in search for their food resulting in less regeneration of forest and grasslands causing erosion, especially problematic at high intensity rainfall after dry spells.

Measures
There is no programme yet for new grass types for improved mix grassland. There is a project for a stable for 2 head to collect manure - Aatma project – 100 mangers will be constructed. Tribal dept. provides help of Rs3000 for the construction of mangers for 2 animals.
More feeding on stable is an option but there are no design criteria for ideal stables as yet.

Action for Food Production AFPRO

Monday September 30 PK Dutta (unit manager); Bidgit Umar (hydrologist)
National NGO with 10 regional branches. AFPRO established in 1966 after severe droughts and famine supporting Green Revolution. Further specialised in relief for food, groundwater for irrigation, (60-70), livestock, watershed management (80^{th}), NRM (90^{th}), socio-technical research on water, food security and livelihoods, watershed energy. Works for local NGO with socio/technical advise from overhead government studies (previously with support international NGO).

Climate Change
Approach: AFPRO made timeline discussion with people of different ages asking for CC effects, impacts, cooping following how to cope and capacity building

Min Environment and Forest assignment prefers working with 2030 projections rather than 2080 (too insecure). Modeling work is done in Indian Institute for Tropical Meteorology (IITM) in Pune.

Climate condition Udaipur: 2006 relatively wet year, 2007-8-9 dry and 2010 good rainfall again. (nice diagram on the wall).

Measures and policies chains. Before the buffalo was considered as less fit for dry conditions, now trials proof he can survive with dry fodder. Goats are more resistant but are destructive to the environment. Per family the number of cattle went down; maybe goats went up.

Watershed approach by water budgeting; combinations of water techniques can used included boreholes. However under management site flexibility is required at the demand like during the Rabi; irrigation of wheat should be avoided when competing with drinking water. common law gives priority on individual use. At community level this still could be an operational rule. The connectiveness of places for water infiltration, groundwater storage and wells and influence of water extraction needs a hydro-geological assessment of the area. Seva Mandir is currently using this approach in 12 villages to understand the current status of groundwater (2011).

Capacity building of designers and users is most important especially on soil and water management; more important than structures.

Forest Department

Monday September 30: Conservation of forest. A.K.Upadhyaya (chief);.R.K. Khelrapal (Seva Mandir, previously Forest Dept))

Pressure on forest is enormous, already since independence. Industry, towns (timber), people (fuel, farm, cattle). Intensive grazing makes regeneration difficult causing erosion. Protection of forest could not be implemented even after the 1990 allowing the management by the communities and the Forest Rights Act (2006) allowing the use of forest land by the dwellers. Basic is a proper land use policy of revenue areas; which should be better protected with trees and pastures under local governance. Now the roads below not protected revenue lands are muddy after rainfall whereas not below well managed slopes.

Recent approached: to allow several functions in the forest but under stewardship:

- let cattle graze in the forest with a cow-ward. Not entering cattle the forest unguided has been a major argument of forest conservationist for long.
- collect forest products for livelihood of the people
- precious plants, like medicinal plants, should be identified, propagated collected and could be sold to the government
- small parts could be replanted after successful protection by the community over 10 years and grazing and trees can be used: Joint Forest Management (JFM)

Example management of 4 year old bamboo has been transferred to the Forest Committee in the village after investment of 2-3 leg Rps.

Biodiversity (variation of trees has been improved.15 yrs back only 4 species; later 8 – 10 species; last year extinct species has been regained grace to the involvement of the local community. In forest on slopes preferably use of trenches rather than terraces and many other techniques.

Maharana Pratap University of Agriculture & Technology (MPUAT)

Monday September 30; S.R. Maloo, (director of Research), , multi disciplinary Climate Change team: T Hussein (insects), Trimid (plantpathology), GS Tuhar (agronomist), PK Singh (rain, soil and water management), Prem Solihki (meteorologist absent). Later visited mrs Kusumat (planrpathologist for Razinrot in ginger). Seva Mandir agriculture (…), Ronak, Fons

Recently erected group on climate change organizes in January National seminar on Impact on Climate Change.
Research in line with of farmers observations on climate change:

- Study on temperature tolerance of plants (like wheat) within different T tranches
- Insects came up as crops suffered from lack of rainwater in 2007-08-09
- Diseases in maize as observed by the farmers during the field visits can be confirmed

Water harvesting is considered as a low cost and effective measure for dry spell after 1st rain of the monsoon and for Rabi irrigation and/or recharge of groundwater.
Observations MPUAT: Crop production under higher temperature changes goes down as is proved by other scientific studies from India and The Netherlands.
Biodiversity at present and influenced by climate change at all levels from plant to molecules.
Millet and Hosgram are strong and nutritious crop which will introduce green revolution for rainfed areas. As in 70-80th the new HYV crop varieties.

Geography department of University Mohan Lal Sukadya

Tuesday 31 august 2010: R.N. Vyas, L.C.Khatri, I.M. Kayamkhani

Khatri stressed the importance of (long term: 40 years+) planning. The development of most cities was taken as an example: were the required water resources well planned? Udaipur just missed a disaster by the additional Maansi Wakal reservoir. Kota has its water planning on order by 3 dams in Chambal river. Also the industrial need for and impact on quality of water is not planned like the Zink smelter, the industry in town and water need for the increasing population. Also spatial planning of the cities is haphazard New townships are well planned but old criteria changed: 2 wheels become 4 wheels vehicles resulting in congestion on the roads (in preparation ' the dying cities of India). Special request for recent topographical maps (1:25.000) van be done in Delhi.

Climate change in Mewar 40 years before 65 rainy days now 40 rainy days; before Tmax from 43 deg now 45 degree.
Other drivers than climate impacts (also) cause competing claims on water:

- Lowering of the water table has consumption and production aspects
- HYV makes small landholdings more productive and causes higher water use
- Crop pattern 40 years before was sugarcane and paddy, now maize and pulses
- Land has been occupied by rich people, government and revenue land

Land policies in relation to forest : at the moment of the land reform to give land to the landless, government had no money and had to sell trees, toy industry uses forest, timber need for construction in town expansion, fuel for farmers charcoals for town and land clearing.

Water resource management by Ahar 4000 before Chr. in relation to reuse of water in the Ahar through ring well system (earth infiltration through mud pipes back in the river)

Groundwater expert

Tuesday 31 august 2010: J.C, Dukey worked for AFPRO, World Vision and for department of Groundwater.
Regional analysis:
Semi-arid climates create fragile ecosystems as they depend on monsoon; variability is heavily influenced by the mountainous area of Avaralli range runs from SW to NE over 850

km. In the east rainfall is higher (8-1000mm) than in the west (2-400mm). Monsoon takes 90 days from year (June till September) of which 24 rainy days; before 30 years was that 40 rainy days. Changes between east and west monsoon depends on distribution of atmospheric pressure. Kotra profit from high rainfall because of advection.

Impacts of CC:
In hard rock area surface water is important and less options for storage of drinking water. In the past people lived on the mountain top as rainfall was apparently enough. All streams are seasonal. Human intervention disturbs catchment. Wells have shallow water tables: sometimes less than 20 cm. Well yields depends on fractured porosity. The rock has been folded sometimes 8 times. Irrigation in winter comes from groundwater only and always will be limited. Question: effectiveness of reservoirs? Open well is costly in relation to tube wells but allows adjustments in time. A pump may work for 3 hrs in a well from 5 – 25 m and source becomes dry and need 8 to 12 hours to fill-up again. Slower lift systems like Persian wheel may provide water over a longer time.
Pumps may run on diesel what becomes more expensive now and electricity seems an option. Most sources have been overdrafted. So groundwater systems already are not sustainable and decay of the water system will follow climate change or improper soil and water management and create migration to the town
.
Conflict between private and village property: mostly in general understanding the village interest for drinking water prevails.
In Kunday area a water bank has been established as a pilot.
Optimum well depth can be obtained from the website of the department Groundwater.
Optimum well distance is no use in rocky area as sources are very local and may have their own watershed.

The bigger water market is between cities, industry agriculture and villages. City's interest clearly intervenes in village interest in Dalgaon (Maasi-Wakkel new reservoir). Timber interest of cities and industry influence forest and water conservation. For efficient use of resources pricing of water could be an important instrument. Tanker usually brings water to needed hamlets mostly fro outside the region.
New idea: the forest area could be open for grazing if attended by a cow-ward and some type of agriculture. If too intensive use, control will be needed. In this way forest remains fresh.
At some places water well fields could be identified to assure the source.

Any science policy network could open-up views on this issue and more attention to planning
.
Transfer of knowledge meanly through learning from the farmers.
Important is de relation :
Development // legislation //operational cost.

For farmer food comes from maize/ wheat; cash will come from migration, but better from irrigation and cash crop
Buffalo's mainly for milk, and banking but need water and green fodder.
Diversification in the village is no 1.

Seva Mandir

September 6
Presentation of Preliminary results at the Seva Mandir Conference hall
Fons Jaspers and facilitated by Ronak Shah.

Main conclusions of the presentation: applied methods were successfully used, like visiting a village twice, link climate effects with local impacts, assignment for excursion; scenario building based on extrapolation of local impacts; discuss in the thematic groups homeyard, agriculture and environment; reporting back from the groups and plenary discussion; link adaptation measures with other drivers, planning of a 3rd visit to discuss a feasible package of measures.

In the Intermediate results of visits to the villages and selected institutes for Seva Mandir staff, block coordinators and representative of visited institutes at Udaipur. Discussion was focused on here issues: 1. What changes take place at village level, 2. which role Seva Mandir can play in main streaming climate change? 3. which si the proper enabling environment for Seva Mandir.
discussion was channelled according three leading questions:

1. Are changes in the communities as observed?
    1. Peoples indeed open up in 2nd meeting
    2. Less cohesion in villages is noted, before adsi padsi (give and take)
    3. Cash attitude is immerging in subsistence villages
    4. Before watershed with forest and sufficient water for 2nd crop (hirma culture)
    5. Also wage labours and migrants still want back to the rich watershed of their village
2. Which role Seva Mandir can play in mainstreaming climate change ?
    1. Different needs for training
    2. How to introduce CC in work on the commons
    3. Complexity of many conditions for growth
    4. Mitigation work to continue
    5. Awareness raising
    6. Strengthen existing measures
    7. Start the dialogue
    8. Use old plant varieties
    9. Emotional and practical issues
3. What will be the proper enabling environment for Seva Mandir and useful relations with science and policy? The question was not answered by lack of time.

Points shared in Hindi during discussion:
Manoj Paliwal (Badgaon block)-

1. Community in Chhali took time to engage in the discussion. During first round, perhaps it was a large group or topic was difficult to understand, as a result not all were sharing their experiences.
2. Changes in rainfall, agriculture and forests are certainly felt in the region and experienced by communities.

Vimal Jain (Head office)-

1. Earlier more people were involved in farming so there was a system of helping each other. Locally the system is known as *Adsi-Padsi*. However, the system is not functioning now a days.

2. Crop pattern has also changed a lot. Rainfall was unpredictable even in earlier days but people had developed their coping mechanisms. Small crops like millets were based on varying rainfall pattern but people do not grow them now.
3. Due to migration, animal husbandry is also affected. Today there is less number of animals per household, including migrant families.
4. Villages are affected by multiple drivers- cash economy pushing the farmers. However, is that the only factor influencing the farming?

Narayan Ameta (Head office)-

1. Rainfall reduced over last few years as forests has degraded. Before, streams used to flow for longer time as people regularly invested on soil and water conservation.
2. Earlier lot of produces came from forests.
3. In this region, there is a concept of "Hirma" Agriculture, in which farmers grew winter crops in soil moisture. That kind of farming is decreased as moisture content in soil is reduced. In result, people also stayed in villages for long time in the year.
4. Today, with less water agriculture has come down so people have to go for labour work.

Lalit Mohan Gameti (Kherwara block)-

1. Earlier more lands were available so people use to grow various crops in which many of them were with less water. Today need to earn as much as possible from small patches of land. So, high productivity seeds and chemical fertilisers are used.
2. More population- need for cultivable lands so forests encroached.
3. People still like to stay in villages but their consumption pattern is changing.

Narayan Ameta (Head Office)-

1. Community has adjusted itself- old people in households are managing livelihoods in village while youths are working in cities to earn additional income.

Yakub Khan (Head office)-

1. Understanding of communities on climate change will have to increased- can incorporate it in current capacity building programmes of village institutions.

Narayan Ameta (Head office)-

1. Activities for reducing energy consumption in cooking, irrigation etc. can be taken up more.

Abhay (Head office)-

1. Attitudinal shifts among youths towards agriculture and mitigation practices. Dialogues between different generations on these issues should be facilitated.

Angela Jacob (Head office)-

1. Communities should be helped to shift towards traditional crop varieties.

ICCO New Delhi

7 september
Frederika Meijer, regional office India, Pakistan, Afghanistan
Poonam Kaur, food security, 4 studies 2005 of food status in N S E W, agriculture is base of livelihood, CC may come in programme for 2011.
Shaika Rakshi, Food security and climate change, FLNF ? network for mitigation. NGO's CM project: biogass, stoves,adaptation and foor (Seva Mandir participates).

Fons:
Learning from vulnerability and adaptation work in Seva Mandir villages :
1. Need for (visionary) long term planning translated in scenario building based on extrapolation of impacts.
2. Other drivers are considered than climate change: Concept of homogenous sustainable village is not realistic
3. Follow multi-sectoral approach in formulating packages of measures.

Ronak
This pilot brought science in Seva Mandir work.
Important initiative to communicate with community on Climate Change
Reactionary planning becomes anticipative planning
Progamme; meteo data, selection of villages, 2 rounds in village (1/2 and 1 day)
Meeting with institutions, climate scenario, prioritizing of issues, work groups, report back
CC gives new dimension to SM work

Challenges
1/ Rainfall data easy available at Teshil level and damsites of PW, temperature is available in Udaipur only.
2/ Planning in the future: statistics meteo data linked to observed impacts farmers.
Climate projections are less stable till 2030 and more secures thereafter.
Alternative: identify CC impacts till now then extrapolate impacts over 15- 20 years which is understandable for communities to talk.
3/ In a later stage of the process -once used at the process mind setting- longer periods can be used to confirm a development or indicate a trend switch.
4/ stimulate innovations and search in the discussion for windows of opportunity
(reply to Shaika question: how to formulate operational strategies with the limited climate data)
5/ follow-up work Seva Mandir

1.SM 3rd visit with the farmers with concrete work as output
2. initiate process in 2-3 other blocks
3. initiate same process in other SM projects: more or less CC related. and mainstream CC in 3 year plan Seva Mandir
4. link with institutes for climate, planning, agriculture, irrigation,. (university form Norway ???name)
5. linkup with politicians to identify priorities and formulate issues (when, where and how) and with departments on advise, regulations and control.

.
Shaika:

1. what are learning initiatives for 2011 new business plan to be ready in November December 2010
2. what is the science base of CC
3. scaling up, training

General reply: Because of complexity climate change also other Seva Mandir activities are to be involved as they may experience impacts of climate change as well as provide support to adaptation measures, like activities with youth, social programmes, homeyard (women), health, education, and external relation (science, policy and sectoral stakeholders) and on monitoring and local applied research (local temperature and pluviometers)
Ad 1 Some ongoing activities can be redirected to support adaptations measures.
Ad 2 we can speak from triangulation: allow communities to combine climate trends and climate model projections with locally observed impacts of climate change.
Ad 3 training on some concepts and approaches for wider application and integrated lessons learnt at government levels

Shaika
Training on main streaming CC in policy
Training on participatory long term planning based on implementation by participants of the training. Use concept of training and development.

TERI

Lodge Rd, New Delhi 6 sept 15:00,

Work of High-Noon group on vulnerability and Adaptation with main issues ± water agriculture and health in research and training. Training- research project on 'Policy making under uncertainty' in 5 states. All state level projects are with various status

Farmers are already faced with many questions and top down government faces them with climate change issues. Problem is both- farmers do not know as well as some govt. policies- and way of working creates additional concern for the farmers. This could be an issue for discussion at state or district level for policy-research.

Approaches: Seva Mandir. scenario building and work groups at community level covered by district policy and supported from Teshil level services.
Teri: scenarios of the state, experience of famers, measures at selected project level

Experience with networks: Suggestion for a (trans) national network on CC adaptation; possibly on the web India (country or continent). Internal project website with option for questions exists. Not yet public
In Rajasthan is a pollution control website. For wheat are social transformation projects.

Ashish Aggarwal: Community based impact extrapolations are at village level probably more reliable than climate modelling. Preferable measures are 'no regret' measures. Not sure at which moment visionary based robust and innovative measures becomes important.

Annex 6 : Useful definitions

HALICUT / ANICUT: low and wide dams built of flat-stones. It slows down the water flow of a stream (NALA), facilitate infiltration water to the groundwater and sedimentation toward valley terraces. Farmers are generally allowed to construct them till 2 m high at a max.

KHARIF, 1st season, monsoon period, summer (autumn), variable duration between May-October with crops: millet, paddy, maize, pulses, groundnut, red chillies, cotton, soybeen, sugarcane, turmeric.

NREGA: National Rural Employment Guarantee Act) public work to create infrastructure and provide income in rural areas. NGERA implemented through the District Rural Development Agency provides 100 rph per family for 100 days/yr = 10,000 per year max as social minimum.

RABI, 2nd season, winter with crops: wheat, barley mustard, peas, oats, kadli.

SARPANCH drinking water tanks in Udaipur district bringing water into the Hamlets (fala) in periods of water shortage.

SAVRI festival
Local festival where each village brings forward a theatre groups which tours through the area during the lean season of the monsoon period. Special for the women this is an yearly attraction.

ZAID, 3rd season with crops: water melon, musk melon, cucumber, vegetables, fodder crop.
Rabi and Zaid crops are mostly irrigated.