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From climate change to changes in agriculture, land and water at village level: a prospective approach in India

Agriculture in India is greatly concerned by adaptation issues as climate change is predicted to have a significant impact on cultural conditions and consequently on food safety. There has been a call for local measures to adapt to climate change and for the participation of local actors. In this context, we used a prospective study framework to discuss changes in agriculture, land and water with farmers in Sorapet (South India). This article presents: the method applied; the changes in this village within the past 10 years; the three contradictory scenarios for 2040 as discussed with stakeholders. The prospective exercise produced an interesting setting for the dialogue between farmers and researchers which resulted in focusing on issues such as the former's strong link to agriculture. Participative prospective alongside local stakeholders, as in this study, is new in India. This experience confirms the usefulness of the prospective approach in promoting alternatives. However, it has to be developed while further questioning its departure from local practices.

Challenges of adapting to climate change and prospective approaches at local level

Agriculture represents the core of the Indian economy and provides food and livelihood activities to much of the Indian population. More than one fifth of the world's farmers live in India, which has over a billion inhabitants to support and feed. India has succeeded in becoming one of the world's leading food producers, yet at the same time it is still a land of poverty (Landy and Dorin, 2009). In this context, climate change is projected to have a significant impact on agricultural conditions due to raising temperatures, unpredictable rainfall, longer periods of droughts, rising sea levels and freak meteorological phenomena. In India, as in many other places in the world, there has been a call for local adaptation. Indeed adaptation to climate change is mainly local, and its effectiveness depends on local institutions (Agrawal, 2010).

Recent studies have illustrated how participatory prospective approaches can be used to explore possible innovative practices regarding climate change, while also considering radical paradigm changes (Faysse *et al.*, 2014). However, studies have reported challenges and difficulties in involving economic actors and stakeholders in discussions related to the changes that may occur

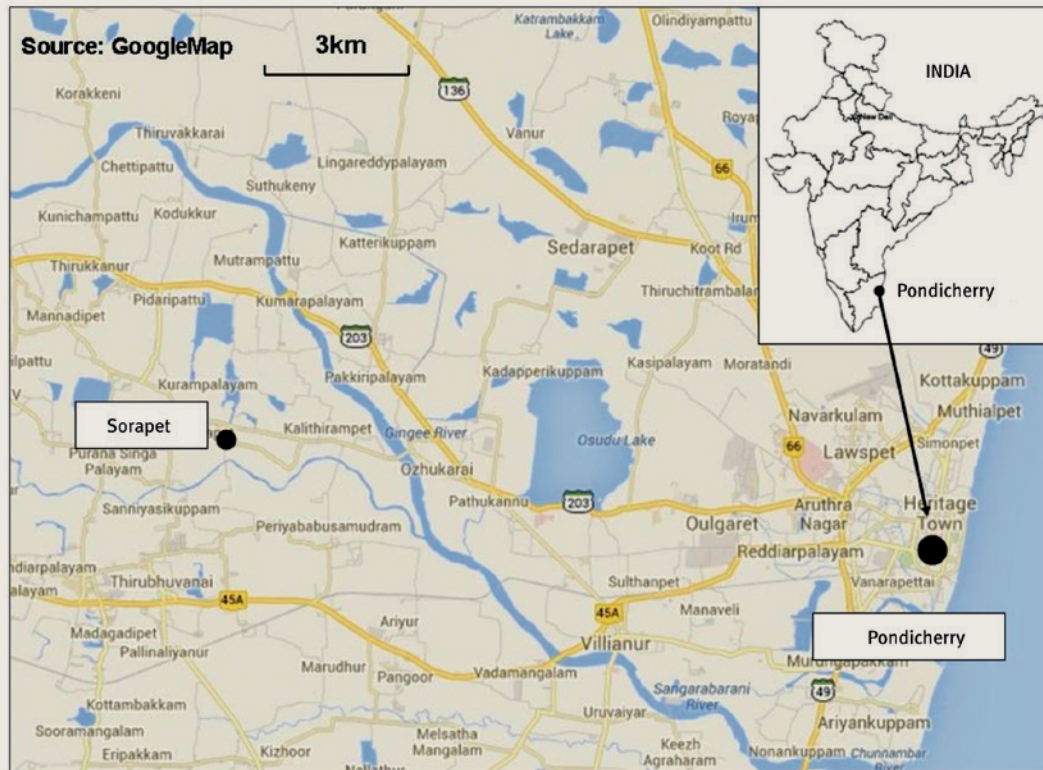
with a certain degree of uncertainty in the long (2030) or very long term (2050 to 2100). The actors involved may not regard climate change as an urgent issue, because they are faced with many other difficulties such as labor issues or the volatility of markets. This is a real challenge as prospective approaches and participatory processes involving farmers are uncommon in India. Planning is customary in public policies at national and state level, with the Future 'visions' of agriculture being clearly defined¹. Yet prospective studies are not often carried out, because reserved for policymakers, and most of these studies focus on technology, industries, etc.

In this context, we used a prospective study framework to discuss with farmers the changes in agriculture, land and water in a context of climate changes (Van Klink, 2015). We carried out this work in Sorapet, a village 15 km west of Pondicherry's urban area (South India, Figure 1). The administrative unit of Sorapet covers 435 ha and has a population of 5,110 (Census, 2011). In 2006, this village was selected for an analysis of its capacity to adapt to water scarcity and to understand why watertanks² were no longer used for irrigation (Aubriot 2013). Over the last 10 years, many changes have occurred under the influence of Pondicherry's growing urbanization.

1. For example Government of Tamil Nadu. "Vision Tamil Nadu 2023: Strategic Plan for Infrastructure Development in Tamil Nadu." Chennai, March 2012.

2. A watertank (or Eri) is a rainwater harvesting system which has multi-functions, the main one being to irrigate crops.

① Map situation of Sorapet, 15 km west of Pondicherry urban area and the imprint of tanks in South India.



The next chapter shows the methodology used for this study. We briefly describe the changes that have taken place within the past 10 years regarding land, water and socio-economic aspects. All this information has contributed to envisaging future scenarios. The discussions about these scenarios with local stakeholders is described in Chapter 4 before the final discussion and conclusion.

Different sources of data and participatory workshops

Documentation of past and present trends and participatory selection of variables

One challenge in this study was to take land, water and the agricultural system as a whole and to identify the changes in this complex socio-ecological system. We aimed to adopt an integrated approach and therefore used several sources of information to identify changes in land and water uses in Sorapet within the last decade. Our main data came from two main sources: first, from surveys carried out in 2006 and 2014. A similar questionnaire was used in 2006 with 50 farmers³ and in 2014 to survey 49 farmers, of whom 90% were either the same farmers or family members of the farmers surveyed in 2006. Second, Adangal⁴ data was used to create maps of Sorapet in 2004 and 2012. In addition, eight interviews were conducted and data was gathered from different actors (NGOs, administration, scientists).

The results were presented to the farmers taking part in the study during an open meeting in the village temple in March 2015 (Picture ①). Over 40 farmers attended including three women. They discussed the results, gave their opinion on major past and future changes and ranked the variables of change. We collected 52 sheets containing opinions in Tamil or English, regarding past and future changes. For example a farmer told us: *"In the future nobody will do any farming because it is not valorized and the financial return is too low"*.

Workshop scenarios

The variables identified by the farmers were used to create the storylines for scenarios, combined with future perspective that were taken from literature. Because of the lack of quantitative data, qualitative data was mainly used for the scenarios. The prospective exercise was a novel experience for the participants. The word "future" does not even exist in the Tamil language. In this context, we chose the scenario method and asked the participants what they wanted for their children and grandchildren and what steps they could take to reach this goal. The timeframe for the scenarios was 2040, because at that time some of the farmers' immediate family members

3. According to the census of 2011, there were 102 cultivators in Sorapet in that year.

4. Adangal data is the data of the land cover, available at the Village Administration Office (VAO).

① Workshop, March 2015:
Left: participants writing their
opinions about past and future
changes – Right: Farmer using
green stickers to identify
main variables of change.



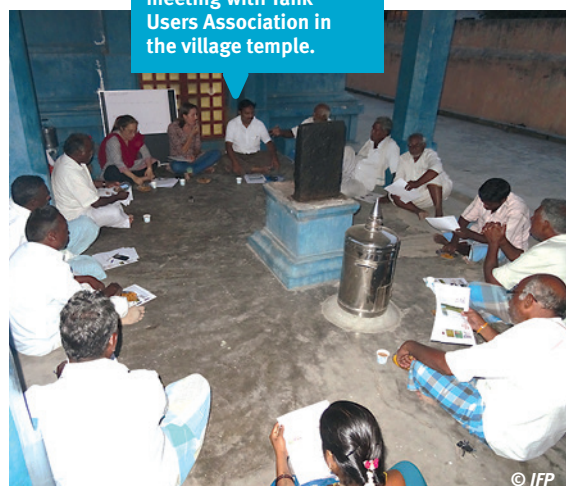
would still be alive and climate change would already have played a role. From the prospective scenarios presented, the farmers could prepare their own scenario. The scenarios were discussed in April 2015 (Picture ②) with ten farmers from the Tank Users Association (TUA), a local institution that is liable to support local adaptation to climate change. After the first workshop, the members of this association were interested in going a step further in the process while requesting support to update their strategy. According to the TUA rules in Pondicherry, the TUA board also includes a woman, Scheduled Castes⁵ and landless laborers.

Past and present trends: Changes in agriculture, land and water uses in Sorapet 2004-2014

Urbanization and shifting from tank irrigation to tube wells

Land occupation has changed at a fast pace in Sorapet. The area now covered in plots (real estate), brick kilns, casuarinas⁶ and buildings has grown and is expected to continue to grow. Meanwhile, the average size of farmer's land has decreased by 2.1% per year (between 2006 and 2014), in keeping with to a general trend in India. The crops grown in Sorapet have also changed. Paddy, sugarcane and cowpea cultivation has increased significantly while groundnut cover has decreased. The proportion of water-greedy crops is on the rise. Indeed, water is an important issue in Sorapet but of secondary concern today even if climate change and population growth may have significant effects on the quantity and quality of water. Since 2006 almost all farmers own at

② April 2015: Foresight
meeting with Tank
Users Association in
the village temple.



least one tube well and rely on groundwater for irrigation. Even though the setting up of new tube wells in Pondicherry has become stricter⁷, we found an increase of 46% in the number of tube wells in Sorapet between 2006 and 2014. What is remarkable in Sorapet is that the groundwater table has risen over the last decade from a depth of 35-40m in 2004 to 25-30m-depth in 2014 thanks to a check dam that had been built across the river. Nowadays, the three main water tanks⁸ in Sorapet are no longer used for irrigation but for other purposes (Picture ③); one tank has been encroached for logging and grazing, while the main tank is used for groundwater recharge, and several small ponds are used for fishing.

5. Official designations given to various groups of historically disadvantaged people in India.

6. Casuarina: a 3-6 year tree crop used for paper or for construction purposes which needs little manpower and water, yet has high investment costs.

7. Since 1997 the aquifers of the Pondicherry hinterland have been classed as 'over-exploited'. According to the Easement Act of 1882, water use is connected to land ownership and land owners are free to extract and use water as they like. In keeping with the Pondicherry Groundwater Act 2002, well owners have to register their wells and the government can refuse permission for new wells. Although the government is strict concerning new wells, old wells can be deepened and open wells can be converted into tube wells.

8. Water tanks used to collect enough rainwater to irrigate the crops, but since the introduction of modern tube wells during the Green Revolution in the 1970s, tanks are less used and maintained (Aubriot, 2013).

A decline in agricultural labor and income, mechanization and a loss of interest in farming

Besides changes in land and water uses, there have been significant socio-economic changes. Farmers and their wives have changed their secondary activities from agriculture-related activities to small businesses or company laborers. Additionally, almost all the families surveyed had at least one member working in the secondary or tertiary sector. The literacy rate of these families was high with the younger generation mainly being highly educated and less interested in farming. Besides, farm laborers have lost interest in agriculture; they can often get better-paid jobs in urban areas or take part in NREGA⁹ programs. According to farmers, mechanization is the main result of the labor scarcity issue. The average income for the farmers surveyed was 2,800 rs/acre/month¹⁰ in 2014, which is below the national poverty line of Rs 36,000 of annual income. Marketing agricultural produce is the main problem today, because of the high variability in selling prices. Crops are mostly sold through intermediaries. Direct marketing is not common in Sorapet. Of the farmers in our study,, more than 50% are members of a farmers' organization; the farmers identified collective action as one of the major platforms to implement future adaptation strategies. The farmers identified a labor shortage, low income and less interest in farming on the part of the younger generation as the key reasons for the decline in agriculture.

③ Paddy nursery, a shed for the groundwater pump on the right and land plotting for real estate in the background, Sorapet, February 2014, close to the main tank which is no longer used for irrigation.



Three scenarios

Based on previous results, we prepared three contradictory scenarios. An overview of the scenarios is given in Table ① and the discussion about the scenarios with the Tank Users Association is described in the following paragraphs.

9. NREGA (National Rural Employment Guarantee Act) guarantees 100 days of work per year for every rural household that is willing to do unskilled labor.

10. 85 euros/ha/month (1 acre = 0,4ha).

① Description of the three scenarios

	Scenario 1: modernization and export	Scenario 2: urbanization	Scenario 3: Pondicherry's food bowl
Public policies	Liberal policies and subsidies for mechanization.	Urbanization-oriented government, focus on industrial economic growth.	Subsidized drip irrigation and training courses, strict water policies and creation of water boards.
Land size	Only few farmers have intensive large-scale farms.	Small plots with houses, large plots with industries, no farmers.	Small- and large-scale farms, fewer marginal farms.
Land cover	Mainly (hybrid/GMO) paddy, a paddy processing factory and some houses.	Mainly built-up (industries, houses, college), some real estate and brick kilns.	Vegetable, karamani, millet, legumes, nuts, trees, barren land, some factories, cattle and houses.
Water	Polluted water, deep tube wells with new cleaning technique, no drinking water.	Polluted water, scarcity of drinking water, low groundwater recharge and flood risk, imported water for domestic water supply.	Water shortage, groundwater for domestic use only, tank rehabilitation, drip irrigation, high electricity prices.
Marketing	Sold to large supermarkets in Europe. Contracts with wholesalers and distributors.	No marketing.	Produce supplied directly to stores in Pondicherry and end products manufactured in Sorapet, green economic growth and quality strategies.
Economy	High input costs and higher income, results in high living standards for remaining farmers.	Earn a lot of money by working for companies and factories, attracting many newcomers, many have a better standard of living.	Low input costs and moderate income, many turn to alternative activities, like working for food industries.
Interest in farming	Much interest on the part of large-scale farmers, only rich farmers gain respect, drop in number of farmers.	No interest in farming at all, big variation in income, no respect.	Interest in farming because of social recognition and better income opportunities.
Labor	Specialized well-paid labor, though machinery is mainly used.	No agricultural labor, everyone works in industry and other businesses.	Labor needed, but still scarce, family farming and machinery used, crops cultivated with a small workload.
Collective action	Little collective action, work mainly individually but machineries collectively owned.	Mobilization of citizens against environmental degradation caused by urbanization.	Innovation platforms, communal storage, processing and marketing cooperatives, NGOs help to boost collective action.



Scenario 1: Extreme modernization of agriculture, export-orientated in 2040

Farmers responded positively to this scenario, because they want to continue farming or at least wanted farming to continue in Sorapet. Yet they saw two major problems: the high water requirement and at the same time water pollution by the chemical fertilizers and pesticides. They said that they should save water for this scenario, for example by rehabilitating the water tanks. One farmer even suggested that it would be better to cultivate organic millet for export instead of conventional paddy. The opinion of the farmers about the probability of this scenario was divided. Some think that this scenario is impossible, because the land has already been converted into houses and factories. Others say that it is possible because of the high paddy yield and the opportunities for mechanization in Pondicherry. Therefore, this scenario came second in terms of both preference and probability. Farmers said that they would have favoured it more if tank rehabilitation and collective action had been taken into consideration, whereby more farmers could profit from the economic growth.

Scenario 2: Sorapet 2040, real estate and industrial area in the Pondicherry suburbs

This scenario was less popular with farmers; it scored lowest in terms of both preference and probability. We actually expected the probability of this scenario to be higher, because of the trends observed and the witness accounts collected in the survey and our first meeting. At the second meeting one farmer told us that he had had to sell his land to pay for his daughter's marriage: "there are so many people like me. In that case, they have to move, there is no other choice for them". Farmers blamed the government for these changes. They expect farming subsidies and the regulation of agricultural land conversion and industrial land and water uses. They consider that if the government does not give subsidies to small-scale farmers, agricultural land conversions will escalate. Farmers see domestic drinking water, floods and solid waste as the major challenges in this scenario. Some farmers also see advantages in this scenario because of the increase in job opportunities and economic growth.

Scenario 3: Sorapet 2040, Pondicherry's food bowl, but limited access to natural resources

This scenario scored highest in terms of both probability and preference, because it is closest to today's situation with farming on all plot sizes and crop diversification. Some aspects of this scenario were actually common in the past according to the farmers, for example family farming and collective sales. The farmers see an opportunity in this scenario of increasing their profits by the collective sale of fruits, vegetables and millets, and by fixing their own price. This is also associated with increased recognition of their work. Farmers said that if they have storage space and more knowledge about the selling price, they can increase their income by selling at the right moment instead of giving most of the profits to the intermediary. Furthermore, farmers think that it is important to rehabilitate the tank and to have a water board with elected members.

11. As opposed to those of astrologers.

Toward developing prospective approaches in India?

Sharing knowledge and points of view about agriculture, land and water

The prospective exercise provided an interesting setting for the dialogue between farmers and researchers. The input from farmers superseded the researchers' forecasts; which resulted in including some variables that had not been thought of at the beginning. The farmers insist that agriculture is on the decline, because of a shortage of labor and the loss of interest among the young generation. They are asking for policies to boost awareness and interest in agriculture. Their concern prompts researchers to better understand and document this attachment to agriculture and the new generations' relationship to this activity. In the course of recent decades, agriculture in India has declined and lots of agricultural land has been converted into plots of land to build on. Master plans for most Indian cities are in preparation. Though the focus is mainly on the development of urban areas. Although rural areas are often included in the plans, the government does not have a specific approach. Farmers recognized that land use planning and water management are important for a sustainable future and were ready to take part in collective action if the government did not take any steps. The farmers' point of view questions the Indian government's general future visions of agriculture that focuses on an increase in productivity thanks to biotechnologies and to the intensification and mechanization. For example, the Tamil Nadu Vision 2023 report (Govt of Tamil Nadu, 2012) focuses on high-yield crop varieties and intensive farming to satisfy the growing demand for foodstuffs caused by demographic growth. Farmers call for mechanization which appears to be an important variable for the future and agree with scenario 1. Yet they seemed to prefer scenario 3 slightly more.

An unusual exercise that is worth extending

An prospective approach with local stakeholders as in this study is totally novel in India based both on a participatory process and on the need to consider potential futures to adapt measures. This experience confirms the usefulness of the prospective approach in discussing the current situation and in envisaging alternatives. Working with scenarios can be used to encourage empowerment on a local scale and work towards the holistic management of land and water. It can inspire stakeholders to reflect on how their actions have influence the future while considering that several futures are possible. However, we faced some limitations in the use of this kind of forecast¹¹ as some participants do not feel that they have control over their destiny. One of the perspective of this study is to extend the discussion to include stakeholders than those in the village TUA and to up-scale the exercise to the Pondicherry region. Discussing scenarios at administrative and local level may lead to interesting debates to improve sustainable planning in a context of rapid changes. The participatory process also helped to collect data to document changes as data were missing on past and future trends. One challenge for scientists is the limited amount of data available on a regional scale and more specifically future projections of climate change. More information about these changes could improve the scenarios used and their adaptation. Changes in India are still occurring at a fast pace with the challenge of raising the standard of living for most of the population. ■

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