THE SUSTAINABILITY OF SURANGA IRRIGATION IN SOUTH KARNATAKA AND NORTHERN KERALA, INDIA.

Crook Darren[1], Tripathi Sudhir[2] & Jones Richard[3].

ABSTRACT

This paper reports the preliminary findings from an on-going research project that is exploring the resilience and sustainability of suranga irrigation technology found in the Western Ghats of south Karnataka and northern Kerala, India. The suranga are traditional adit water harvesting systems that tap ground waters. They have been constructed mainly by individual land owners to provide both drinking and irrigation water. This paper compares traditional suranga irrigation technology with that of more modern irrigation technology, first introduced during the green revolution, in terms of their impacts on livelihood strategies and water use efficiency. The paper also describes some of the recent adaptations made by farmers to suranga systems based on response to new crop growing opportunities and the availability of new conveyance and distribution technologies and materials. The paper concludes by exploring the resilience and sustainability of the traditional system from a catchment based perspective as the region faces the duel pressures of population increase and climate change.

CONTEXT

Suranga are found in the Western Ghats of India. The full geographical range of the technology is yet to be determined, but the major concentration of these systems is found in south Karnataka and northern Kerala. More specifically *suranga* are found in many parts of Dakshin Kannada district of Karnataka and Kasaragod district of northern Malabar (**Figure 1**). Suranga are defined as manmade horizontal adit systems cut into slopes in order to extract ground waters that are used for drinking water and irrigation. The nomenclature of suranga is varied as a result of the linguistic diversity of the region and it is worth pointing out that suranga are referred to by many other names including surangam, *thurangam*, *thorapu* and *mala* (Basak et al., 2005). Suranaga are one of a number of ancient traditional water harvesting systems found in this part of southern India. The most well-known of these are tank and farm pond irrigation that can be used on multiple scales in order to capture water for seasonal

[1] Crook, D. Department of Human & Environmental Sciences, University of Hertfordshire, College Lane, Hatfield AL10 9AB. Contact: d.crook@herts.ac.uk or Tel. +44 (0)1707284240
[2] Tripathi, S. Department of Human & Environmental Sciences, University of Hertfordshire, College Lane, Hatfield AL10 9AB. Contact: s.tripathi2@herts.ac.uk or Tel. +44 (0)1707281025
[3] Jones, R. Geography, University of Exeter, Rennes Drive, Exeter, EX4 4RJ. Contact R.T.Jones@Exeter@ac.uk or Tel. +44 (0)1392723348

periods of water scarcity. These water harvesting systems are often used in conjunction with suranga.

Figure 1: The Dakshin Kannada study site

Current thinking about the origins of this traditional technology is that suranga construction has been influenced to a large extent by Qanat technology drawn from the Arabian/Persian Gulf region as a result of the long history of trade and movement of people and ideas between Malabar and Persia (English,1968; Kobori, 1973; Biswas, 1976; Kokkal, 2002; Doddamandi, 2010).There are clearly qanats found in India, such as Khooni bhandara, that is a unique underground water management system developed by the Mughals in the seventeenth century in Burhanpur, Khandwa district, Madhya Pradesh (Nagda, 2001). The most often cited work (Halemane, 2007; Balooni et al., 2010) in respect to suranga matching this model of irrigation is Basak et al., (2005:222) that is usually shown in conjunction with their figure (**see Figure 2**).

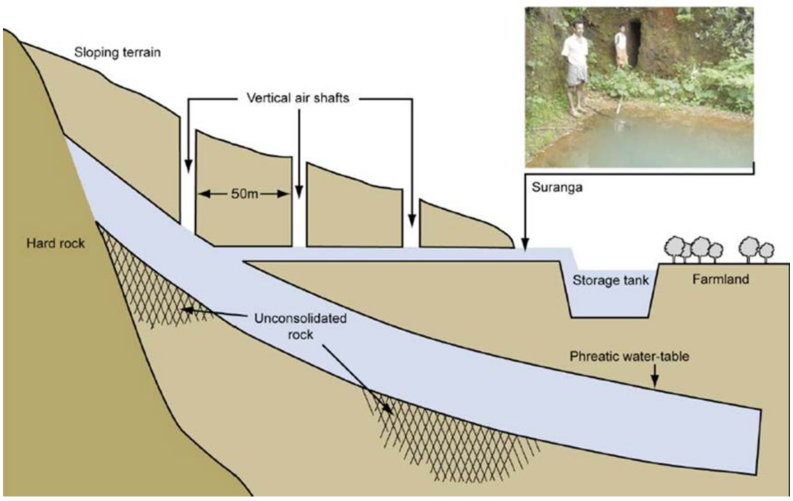

Figure 2: A Suranga system: image adapted from Basak et al., (2005:222)

What is clear is that the current system of suranga expanded in the 20th century, as the region released itself from the shackles of colonial rule and a suppressed agricultural sector that was integral to local livelihoods (see Prakash, 1988). The exact number of suranga is unknown, however, the districts where suranga are known to be found are presented below (**Table 1**).

Table 1. Geographical distribution of Suranga

State	District	Sub-District	Villages (estimated no. of suranga)
Karnataka	Dakshin Kannada	Bantwal	Manilla (~ 300), Peruvai Alike, Kanyana, Keropady, Kepu, Punacha
	Shimoga	Sagara	Banjagaru (4)
Kerala	Kasarogod	Kasaragod	Bayar, Possadigumpe (~ 2000), Enmakaje (panchyat), Adyanadaka, Perla, Padre
		Hosdurg	Kahnangod Block panchyat (5 villages)
Goa	North Goa	Ponda	Priol (12)

It is worth pointing out that water scarcity is not a major problem in this part of the Western Ghats which has a climate that is largely characterised by the timings of the monsoons. The south western monsoon contributes 85.3% whilst the northeast monsoon contributes 8.9% of annual rainfall (Balakrishnan & Saritha, 2007). The rainfall for the region ranges from 3500 mm yr^{-1}(Kokkal, 2002: Balakrishnan & Saritha, 2007) to 5000mm yr^{-1} in the upland areas in Manila village (Krishnaswamy *et al.* 2006). Overall there are four distinctive periods or seasons in a typical year: June to September, South western monsoon; October to December, Post-monsoon; January to February, winter; and finally summer from March to May. It is this latter period when water scarcity is at its greatest in the region, mainly as a result of pre-monsoon showers that account for the remainder of annual rainfall failing. The average mean monthly maximum temperatures range between 29.2 ^{o}C. and 33.4^{o}C with maximum lower mean monthly temperatures range between 19.7 ^{o}C an 25^{o}C. Relative humidity can range from 98.7% to 54.4% with wide diurnal variation. Evaporation has a range of 2.2 to 6.3 mm/day^{-1} with a lower range during the southwest monsoon.

The landscape of this part of the Western Ghats is characterised by undulating upland topography that produces relatively small but steep sloping hills (**Figure 3**) that have in the past been naturally forested until clearance for settlement and farming (Bhat, 1998). The slope hydrology is characterised by a near to surface phreatic water table running down slope at a depth that ranges from 1.6 to 23.9 bgl depending on the season and location (Balakrishnan & Saritha, 2007), in places this emerges as natural springs and small rivulets that eventually drain into one of nine rivers, but with only two of note the Chandragiri and Karingote rivers (Balakrishnan & Saritha, 2007). Down each slope will be found tanks or reservoirs, dug wells, farm ponds and suranga where the soil structure facilitates construction. The main soils found in the region are laterite soils, (~75%) found between the altitudes of 7.6. and 76 m.a.s.l (Kokkal, 2002; Balakrishnan & Saritha, 2007). Laterite soils are highly weathered rocks that are typically rich in secondary oxides of iron (Fe) or aluminium (Al) or both. Laterite is soft and easy to quarry, but it becomes hard once exposed to oxygen which gives it good structural properties in many locations although it is important to recognise that the exact composition of laterites varies in each location (Buchanan, 1807; Thurston,1913; Das, 2007).

Figure 3: Undulating upland topography of Manila village

Landuse in the region where suranga are mostly found is mainly agricultural with a mixture of forest and privately owned land holdings and farm units. The template for this form of private land tenure is pre-colonial and was indeed copied by the British in the form of Ryot farming (Bhat, 1998). There are six types of forest identified in Malabar; deciduous, tropical evergreen, evergreen shola, scrub shola, mixed deciduous and evergreen forest and finally heavy deciduous forest (Prakash, 1988) Arboriculture is practised by many farmers, tenants and coolies. The main tree crops, in no particular order, are coconut, arecanut, banana, rubber, jacknut, papaya, cashew, vanilla and pepper (CWDRM, 2002). There is some wetland paddy grown in flatter of flattened areas of farmsteads and cocoa. Livestock is rarely seen other than the odd cow or goat used for milk and dairy produce. Besides the water harvesting techniques already outlined farmers may also practice contour bunding, check dams, contour trenches, mulching, and cover cropping. Additional forms of irrigation include drip irrigation, spray irrigation, basin irrigation and pitcher irrigation. Intercropping is typically practised and will include clove, nutmeg, mango, plantains, cocoa, arecanut, pepper and fruit trees. Agroforestry may also be practised and include Jack tree, Anjalee, Phylanthus Emblica, Nhaval, Mango, Mahogany, Sandal, Garcinia, Neem and Tamarind.

Tubewells were first introduced into the area in the early part of the 20th century testified by the need for 8 electric pumps for tube wells as recorded in the 1939-40 Agricultural statistics for the area, however because of the terrain other forms of water extraction are more popular. Ground water is extracted through open dug wells, bore wells, hand pump wells, filter point wells, suranga and variations of these. These types of water extraction accounted for ~47% of the irrigated area in Kasarogod in 2007 (Balakrishnan & Saritha, 2007). Borewells in particular became very popular in the Kasarogod district in the 1980s as part of the push for agricultural improvement referred to as the Green Revolution (Balooni *et al.*, 2010). The Kerala State ground water department (KSGWD) provides technical expertise to local government agencies, quasi government agencies, farmers and individuals and identifies sites for tube well, borewells, filter point wells, hand pump wells, open wells and other types of wells, but not suranga (Balakrishnan & Saritha, 2007). Heavy subsidies are also provided by the KSGWD to marginal and poor farmers for survey, drilling and electricity charges for pump sets.

RESEARCH METHODS

This paper reports the results from a comprehensive social survey of agriculturalists in Manila village found in Bantwal Taluk (~720 km^2) sub-district of Dakshina Kannada in the state of Karnataka. The post Monsoon period (Sept-Nov. 2012) was selected for the first survey to access the condition and use of water bodies during that time. A second survey followed in the pre Monsoon (April-May 2013) period to check water availability and water scarcity in the region. The village has a population of 3191 with 516 families (GoI, 2011). A combination of questionnaire survey and interviews were used to ascertain the state of water resources and their use in these communities. The community is predominantly agricultural with a large Hindu Temple, Shree Dam. The majority of the inhabitants of the village are Kaharad Brahmins with just a few Muslim and Christian families. Land ownership is almost exclusively private although sub-letting to lower castes that include farm workers and coolies does occur. The main language and culture is Kannada, but Tulu is also widely spoken, which meant that a translator and facilitator was required to allow access to families and their farm units. In total 50 farmers were questioned and 95 surangas surveyed in Manila village. In most farm units a mixture of water sources were utilised including farm ponds and dug wells. The community also has around 200 borewells (Govindha Bhat pers. comm. 2012).

AGRARIAN CONTEXT

The average size of farm units in Manila is small at about 2 hectares per farm, but with a range from just under a hectare to just below 9 hectares (Govindha Bhat pers. comm. 2012). The main land owners come from the Kaharad Brahmin caste and there are lower caste and tribal groups that sub-let land and provide agricultural labour. The agricultural year begins in April after the feast of Vishu (Thurston, 1912). Livestock numbers are low with usually just one or two cows for dairy produce and some chicken. Agro-forestry is predominant and there has been a recent shift to cultivation of rubber plantations involving the use of terracing. There has been some recent expansion upslope into more marginal, previously un-cleared areas, to expand cultivation. Palm oil production is becoming a more popular crop in the region. Areca nut, coconut and plantains are commonly grown and provide the main income to families. Cashew is found in the village and farming is almost exclusively organic. A possible explanation for this reluctance to use chemicals relates to the spraying from helicopter of the pesticide Endosulfan over cashew crops in State owned plantations by the Cashew Development Corporation at first in Padre Village, Kerala (regular spraying started in 1981) and subsequently over the last 20 years in Dakshina Kannada plantations as well. This has resulted in a legacy of human health problems in the local populous and also damaged flora and fauna. These problems are subject to a major law suit and the use of this pesticide in Kerala has been banned since 2001 (Dewan, 2002). The population of Manila are very close and deeply sensitised to this still unveiling environmental and human tragedy and exposed to the regular controversial newspaper, internet and television reports on the problem.

IRRIGATION

The irrigation period in Manila village runs normally from late November and lasts until the arrival of Monsoon (approximately end of May). The crops that receive the most water are areca nut and coconut, rubber and pepper are not irrigated (Palakkad, 2007). Water is obtained from small seasonal streams (known locally as *todu*), springs, suranga, dug wells, tanks (*kere*) and borewells.

Suranga have been built on most properties by land owners, tenants and hired farm workers, including by coolies with only minimal access to land, in Manila village. The costs of construction are borne by the individual. Generally, there are no loans or subsidies available for suranga construction, however, recently the local government in *Manila* has provided some financial help for making a suranga to a family. Govinda Bhat a farmer in the village states that "For a 50 kolu suranga, we need Rs.15,000 as per present wage rate" (Padre, 2008). This survey included a total of 95 suranga from a grand total of around 300 suranga in the village. The practice of constructing multiple suranga on land holdings is common. The suranga in Manila are generally short ranging in length between three and 250 metres with an average length of 40-50 metres. There is a second type of suranga that is constructed horizontally at the bottom of a dug well or concrete well. These are classically harder to survey and so their dimensions are less well known (Kokkal, 2002). The flow of water is often pooled just before the entrance by building a small earthen dam. The water is then conveyed via a small diameter plastic pipe either into a farm pond or directly into an underground irrigation network (**Figure 3**).

Figure 3: A suranga entrance with piped supply into a farm pond (Source: Shree Padre, 2008).

There can be multiple suranga actually supplying water into a single farm pond. Farm ponds may also be connected by underground networks in cascading interlinked systems down a slope. The construction of suranga is reliant normally on specialised labour and the experience of suranga building is valued by land owners, although it is noted that there is a labour shortage currently in the region and so this experience is declining, and families often resort to independently constructing their own suranga, a process that is not always successful (CWRDM, 2002). One family of note in relation to suranga building is that of Govindha Bhat's which is unique as the family have a land holding that is reliant solely on suranga for both its drinking and irrigation water. This family have acted as, or rather been contracted out, as experts in terms of locating suitable sites for excavation of new suranga for other landholders in the village. This involves the identification of suitable soil conditions at the point of excavation and indicator geo-botanical plant species that suggest a nearby phreatic water table that will provide the source of water. Key biological indicator species for phreatic water table include trees such as dhoopada mara (*Vateria indica*), basari mara (*Ficus virens*), and the fast growing uppalige mara (*Macranga indica*). Termite hills on a row is also another indication of water near to the surface. The majority of suranga convey water into a range of small farm ponds when the water is destined to be used for irrigation. There are a number of new examples of medium sized farm ponds being built on individual plots of land funded at great expense to individuals. A mixed use, that is between drinking water and irrigation, of water sources is typical for both suranga and borewells, but not farm ponds that are predominantly used exclusively for irrigation. Suranga discharge can vary from 1 m^3 day to 50 m^3 day in summer, but at peak summer it will be generally less (Balakrishnan & Saritha, 2007).

Dug wells are constructed to a depth of around 10-15 metres (Kokkal, 2002) or 4.84 m to 24.76 mbgl (Balakrishnan & Saritha, 2007). The diameters of these wells range from 2 to 4 metres. The daily discharge from laterite dug wells is said to be in the range 5 to 60 m^3/day in winter and 2 to 20 m^3/day in summer (Balakrishnan & Saritha, 2007). Lifting devices for dug wells include centrifugal and jet pumps. Borewells in the village supply water mainly for irrigation, but large organisations like schools and temples may also use these as drinking water sources. They can be dug anything from 100 m (Kokkal, 2002) to a depth of around 200-250 meters (Krishnan, 2007) depending on topography and location. Lifting devices for borewells include submersible and compressor pumps. Farmers are able to apply to local banks, usually government banks like Canara Bank and Karnataka Bank, or through cooperative banks like Alike Service Co-operative Bank Limited, Bantval Co-operative Bank Limited, Co-operative Agricultural Bank and Grameena Sahakari Bank Limited, for loans for installing a bore well. In Manila, though there are about 200 bore wells, according to Govinda Bhat. This loan can amount to the full cost of the bore well that is then returned in periodic instalments. As the amount loaned is not huge (in comparison to a loan taken to make a house) a farmer can get this loan without much paperwork. Currently bore well construction is offered by private bore well companies operating from locations like Mangalore and Puttur. One operator estimated that 80 new borewells per month were being constructed in the area at a rate of two a day (pers.comm. April 2013). The amount of water a borewell can deliver varies according to each borewell and their discharges can be highly variable.

Distribution of water from suranga, farm ponds or borewell onto crops is either by hand/bucket, inundation, hose, drip, fogger or sprinkler system (**Figure 4**). In many locations of Manila village there is a large enough hydraulic head between the suranga/farm pond and the irrigated crop to produce sufficient pressure for spray irrigation and misters without the use of pumps.

Figure 4: Combination drip/mister irrigation hoses with a farm pond in the background

The allocation of this water is mainly for arecanut and coconut production. There are subsidies made available for drip irrigation (80-90%), fogger (local parlance often refers to these as misters) irrigation (70-80%) and sprinkler irrigation (60-70%). The relative difference between subsidies for drip, fogger, and sprinkler is accounted for by the increasing level of consumption of water associated with each technology and thus the subsidy decreases a concomitant amount. Scheduling is dependent on the crop that is being grown and its growth characteristics.

CATCHMENT BASED PERSPECTIVES

From a catchment based perspective the question remains how compatible borewells are with more traditional forms of water harvesting of ground waters like dug wells and suranga, as this will in part determine how resilient the farmers are to the duel pressures of population increase and climate change.

The farmer of Manila is on one hand prudent and wise linking the use of different water harvesting, collection and distribution systems in a cascading way down a slope in order to minimise the risk of water shortage in the dry season, but on the other hand they are sometimes also inefficient. In numerous locations it is clear that basic ground water principles and micro-catchment hydrology are understood and this knowledge used to locate new or additional water sources. Nonetheless, even with this wisdom there are numerous examples of collapsed and moribund suranga, and also stories of multiple failed attempts to locate water by digging new suranga in inappropriate zones.

Despite this suranga digging is an option for all and incurs very limited cost to the farmer, and there are some classic examples of farmers who have persevered after numerous failed construction attempts to finally find a reliable water supply. It does seem clear, however, that farmers do not always fully appreciate their impacts on the micro-catchment hydrology of a slope, as some suranga run dry during the summer months, and it seems that there is evidence for over extraction of water down a slope, with little consideration given to the impacts for downstream users. As demonstrated below this is not a problem unique to suranga.

This is also a problem with dug wells that recharge quickly but, because of the porous laterite, drain quickly in areas of topographic highs and hill slopes where suranga are mainly found. This has resulted in the deepening of dug wells and increased demand for borewells (Kokkal, 2002). The problem of lowered water tables has inspired private owners to sink new borewells in an unregulated way to the extent that there are now around 200 borewells in Manilla many of which have faulty construction because of limited technical experience. The loans needed for construction have also put a great financial burden and stress on poor farmers as crop prices have lowered that is thought to explain very high rates of farmer suicide in the region. This over extraction of ground water has resulted in these waters being recognised as over exploited in Kasaragod.

Declining water quality is another concern of the region. It has been found that the quality of water from all sources is variable, but on the whole laboratory testing (Kokkal, 2002) supports farmers perceptions that suranga water is sweeter tasting and purer than that found in borewells. Faecal contamination of borewells has been known partly because of lapsed sanitation around the pump and because of draw down from the water table as a result of over-extraction. Thus in Manila, even though there are about 200 bore wells, only about a dozen still yield water (Govinda Bhat, pers.comm,). Thus, one clear distinction between suranga and borewell extraction is that there is obvious propensity to over extract water in the later whereas the extraction of water from suranga is regulated by availability.

Despite these problems clearly borewells remain popular amongst farmers even if they are not always a long term solution to water scarcity. Whilst there is overlap between where these two technologies are found there is for the most part no desire to abandon suranga use, particularly at the margins of catchments where for now at least, both technically and economically, the borewell is not an option for the poorest and most marginal farmers. Thus, from a broader catchment perspective the two technologies that draw from different ground water sources are compatible, but both may need some intervention in terms of regulation of use and the build-up of greater social capital in the form of creating farmers self-help groups to disseminate best practice amongst irrigators.

CONCLUSION

At its best farming in Manila incorporates both traditional and new water harvesting technologies in a combination that maximises access to water for drinking and irrigation for individual farmers. This combination of water harvesting of both surface and ground waters used in conjunction with retention/storage farm ponds maximises the water security for these otherwise vulnerable farmers and allows them, in all but the most extreme circumstances, to overcome periods of drought and intense heat, as seen in 2013. At the margins of the agricultural system on the steeper slopes near the crowns of hill tops where the poorest people with the smallest land units live it is often not technically or economically feasible to build dug wells or borewells and in these locations suranga may be the only water harvesting option. Overall the water harvesting strategies provide these farming communities with a greater resilience to drought than those adjacent communities without suranga. There are signs that the benefits of suranga are becoming more widely appreciated as, since 1986, there has been the development of a hybrid technology by an individual entrepreneur in the form of horizontal tube wells constructed at the base of existing dug wells (Padre, 2006), a technique that recognises the principles of suranga construction. There has also been an example of suranga technology transfer from Dakshina Kannada to Goa as a result of migration of a family, thus demonstrating that where similar hydrological conditions and laterite soils are found elsewhere in the Western Ghats there is the propensity for a further expansion of the technology. More recently as a result of this research the Development for Humane Action (DHAN) foundation have showed an interest in suranga thus demonstrating their potential important humanitarian role in this part of India, as it is a cheap simple technology open to all regardless of caste and poverty.

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