

## Analytical framework for socio-economic system mapping

Research note

**Declaration:** Following research note describes about the analytical framework for socio-economic system mapping used in the project “Shifting Grounds: Institutional transformation, enhancing knowledge and capacity to manage groundwater security in periurban Ganges delta systems” funded by the Urbanising Deltas of the World programme of the NWO, Netherlands Organisation for Scientific Research under grant number W.07.69.104.

**Citation:** Banerjee, Poulomi. 2016. Analytical framework for socio-economic system mapping: Research note. WP/SG/02/2016, Shifting Grounds project working paper series. South Asia Consortium for Interdisciplinary Water Resources Studies (SaciWATERS), Sainikpuri, Secunderabad, Telangana.

**Cover photo:** JJS.

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**Funded by:** Netherlands Organisation for Scientific Research

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**Summary:** The following research note gives a multidimensional understanding of the groundwater-livelihood linkages in the context of changing hydrological, social, economic, political, institutional, historical and behavioral processes precariously felt in the peripheries of the delta cities. Periurban areas provide a conflicting space where diversified livelihood strategies are co-opted by multiple stakeholders empowered with different assets and entitlements. Such portfolio of livelihood strategies not only helps them to build resilience against external shocks and stresses (increasing population pressure, disappearing ground and surface water, breaking kinship ties, industrialisation, pollution, climatic variability, inadequate institutional support), but also has impact on the groundwater for use by others and future generations. Such combination of strategies might lead to positive outcomes or reproduce/sharpen existing forms of social differentiation, inequality and groundwater poverty. However these inter-linkages as well as issues of conflict and cooperation around groundwater use in a wider context of periurbanisation, climate change, institutions, regulation and cultural norms are relatively under-researched scientifically. There is also a need for an integrated framework that can capture the interaction between livelihood assets, vulnerability and transforming structures (such as policies and institutions) leading to better management/mismanagement of the groundwater in transitory spaces. Following concept note attempts to address this gap by developing an analytical framework to explain such complex interrelationships between groundwater use/misuse, livelihood strategies, conflicts and cooperation in periurban areas of gangetic delta. It forms part of the socio-economic system mapping of the research project titled “Shifting Grounds: Institutional transformation, enhancing knowledge and capacity to manage groundwater security in periurban Ganges delta systems.

**Key words:** Ground water, periurban, Ganges delta, sustainable development, livelihoods

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## I. Introduction

Groundwater plays a very crucial role in meeting the irrigational and livelihood needs (Morris *et al.*, 2003, Qureshi *et al.*, 2015) of vast majority of the farmers living in global south (Foster and Chilton, 2003; Shah, 2006; Giordano, 2009; Bouarfa and Kuper, 2012). Its intensive use has always been justified by its ubiquitous presence, large buffering capacity from climate shocks, relatively low establishment cost, on-demand water availability, easy access by individual farmers, relatively fewer concerns with respect to property rights and high conveyance efficiency (Pavelic *et al.*, 2013; Ganapuram *et al.*, 2015; Narayanmoorthy, 2007; Lopez-Gunn and Llamas, 2008). The result is development of a ‘vibrant wealth-creating’ groundwater economy in many countries around the world (Shah, 2009) providing ‘autonomy and empowerment’ to irrigators, liberating them from ‘state’ water (Bouarfa and Kuper, 2007; Narayanmoorthy, 2007). While the use of groundwater has become quinessential at the event of declining canal and tank irrigation systems, its extraction for domestic and industrial usage has grown exponentially over last few years (Afroz *et al.*, 2011). Impacts of such human actions on aquifer behaviour have been widely studied across disciplines (Mishra, 2011; Shah, 2012). However what will be interesting to see as to how such changed aquifer conditions further alters human behavior. Does it creates vulnerabilities or provides opportunities to manage the resource in a sustainable way? Such an understanding becomes more critical in the context of scarce or under-utilised resources, heightened land-use conflict, uncertainty and profit potential precariously felt in the peripheries of big cities. Periurban areas, which are repository of various geographical and functional phenomena, is a self-contained entity quite distinct from its rural and urban counterparts. Its transitional and vulnerable nature makes the management of the common property resources like groundwater far more challenging. While on the other hand its closeness to the city creates enclaves of opportunities that if effectively harnessed can help in poverty reduction.

Against the periurban context it is therefore imperative to see how multitude of socio-economic, institutional and political and historical processes creates vulnerabilities and shocks for a groundwater dependent periurban household? How household response to such shocks? How and what kind of portfolio of strategies are applied by the households collectively or individually to fight against stress and shocks and adapt to the vulnerable situation? Does varied combinations of strategies and actions, creates pathways of cooperation, management resource enhancement and water security or provokes exclusion, marginalisation pushing vulnerable far below the poverty ladder? How micro processes are entrenched in macro policies and strategies (electricity tariffs, crop insurance, credit facilities, groundwater act, master plans, employment guarantee schemes etc)?

Such understandings becomes very critical in a transitory periurban context marred by rapidly changing landuse and livelihood patterns with institutions not always equipped enough to manage the fast changing needs, demands and aspirations. Following paper that forms part of the socio-economic system mapping of the research project titled “Shifting Grounds: Institutional transformation, enhancing knowledge and capacity to manage groundwater security in periurban Ganges delta systems” aims to create an analytical framework to understand aforesaid questions in a holistic way. The idea is to see whether periurban is a space of opportunity or degeneration with reference to groundwater and livelihoods. The aim is to assess whether it creates a space of interaction between actors and groundwater resource leading to enhancement of income, productivity, wellbeing, resilience and adaptive capacities or multiple interests creates conflicts, exclusion and poverty. The scale of analysis is household, where comparison will made between villages of periurban Khulna and Kolkata.

## **II. Groundwater extraction and transaction: A review**

In south Asia groundwater boom is barely 30 years old starting from south and central India, where the largest stock of tubewell capital was accumulated before 1965 (Shah, 2012). Under the patronage of International financial bodies like World Bank, Asian Development Bank it spread out to, almost everywhere in the region. The greatest increase however in the number of groundwater structures has occurred only during the 1990s (Shah *et al.*, 2006). Bangladesh came up with East Pakistan Water and Power

Development Authority (now Bangladesh Water Development Board, BWDB) in 1959 and the development of the nation's first Water Resources Master Plan in 1964 (Sattar, 1998). World Bank encouraged rapid growth in the tube well construction with 1,128,991 STWs in 2005 (BADC 2005) and 1,374,548 STWs in 2008 (BADC, 2008) in Bangladesh. 1985-86 West Bengal government, launched massive scheme of constructing public dug wells, shallow tube wells, deep tube wells and river lift irrigation with World Bank assistance of US \$ 99 million (Rao, 1995). In Nepal ADB supported shallow tube well irrigation in 1999 on credit basis (ADB, 2012). Access to groundwater through tubewells was thus one of the factors explaining the Green Revolution in South Asia (Chaudhry, 1990).

The trend and pattern of groundwater development varies across countries and states within South Asia. The groundwater development in the water rich Ganga-Brahmaputra-Meghna basin falls far short against the Pakistan, Western Uttar Pradesh and Punjab of India. Sub-continental level survey on the groundwater economy conducted by the International Water Management Institute's IWMI-Tata Water Policy Research Program in 2002 indicated several factors like hydrogeological settings, cropping pattern, technology (small pumps and boring rigs), energy pricing and supply policies (flat electricity tariffs) to affect its development trajectory (Shah *et al.*, 2006). Whatever may be underlying factors promoting its growth; one key element to this revolution was explosion of heavily subsidised private groundwater development (Shah, 2012) altering the economy, society and water politics of south Asia. It ushered a new era of irrigation dominated by numerous small to medium scale private investors making the economy best be described as atomistic irrigation economy (Shah, 2009; Bhaduri *et al.*, 2011; Shah, 2012).

Technical and managerial complexities in public tube wells (Bouarfa and Kuper, 2007; Shah, 2009), difficulties in transferring the ownership of these structures to the irrigators, fragmented landholding, privatisations and deregulations on import of irrigation equipment (pumps and small (<12 HP) engines) (Qureshi, 2015) encouraged promotion of private tube wells in countries like India, Pakistan, Bangladesh and Nepal (Bouarfa and Kuper, 2007; Shah, 2006; Shah, 2009). While assessing the role of public verses private tubewells; Dhawan (1974) argued that under-pricing the irrigation water flowing from public work, leakage of output and inability to produce output up to the

rated capacity of the public enterprise have led to its failure in India promoting the later. Government of India estimates shows that 60 percent of the irrigated areas are served by wells and tubewells built by farmers with private investment. According to the latest round of Minor Irrigation Census (GoI, 2011), West Bengal has 5.19 lakh<sup>4</sup> wells and tube wells, down from 6.14 lakhs in the 3<sup>rd</sup> Census in 2001. Of these, approximately 1.09 lakhs run on electricity and the rest run on either diesel or kerosene or a mix of both (Mukherji and Das, 2012). In the study by Saidur *et al* in 96 villages of Bangladesh reported that in 2010/2011, 1.55 million STWs accounted for around 80 percent of groundwater irrigation, 67 percent of the total area irrigated by groundwater and about 66 percent of total area irrigated in the dry season.

Individual ownerships got augmented through sharing and transactions of groundwater based on market principles. Field based evidences showed that access to groundwater water was not only restricted to medium and big farmers who own the shallow and low duty tube wells. Neither the sharing limited to the command area of the heavy and medium duty tubewells. Numerous small and marginal farmers accessed groundwater through market mechanisms. Researchers reported the existence of informal institutional arrangements from the early 1980s onwards (Shah, 1985; Pant, 2004) playing a critical role in agriculture and rural livelihoods. Such informal institutional arrangements working on the principles of market, transactions investments by a group of farmers (borehole, pump, engine) or shared operation of tubewells, as well as the sale, purchase and exchange of tubewell water, gave rise to what popularly known as informal groundwater market (Bouarfa and Kuper, 2007). Groundwater markets have emerged in many parts of Gujarat, Tamil Nadu, West Bengal, Orissa, Bihar and Uttar Pradesh in India, and in Bangladesh and Pakistan (Rawal, 2002).

Field level data based study carried out in erstwhile Andhra Pradesh found a dramatic change in the cropping pattern in favor of water intensive banana and sugarcane due to intensive groundwater irrigation among owners and non-owners of the bore wells. As a result the demand for labour increased substantially and wage rate increased almost by 50 percent. Agricultural intensification results into increase farm productivity and income of the landowners and landless farmers and finally in the reduction of poverty (Shah and Raju, 1988; Narayanmoorthy, 2007). While analysing



rural poverty Narayanmoorthy, 2007 mentioned that among several conventional variables used to measure poverty like productivity, net state domestic product of agriculture per head of rural population. There exist a significant inverse relationship independent relationship between groundwater irrigated area and the incidence of rural poverty. While explaining the principles by which groundwater market operates Saidur et al describes that the 'irrigate their own and partners' land and sell excess water to irrigate plots of their neighboring farmers not only for neighboring interest but also for the their own benefits. Payment of irrigation water is made in either cash per unit of land or as one-fourth crop-share. Sometimes different mode of rental arrangements is also observed based on values, norms and ties' (Saidur *et al.*, 2012).

Emergence of such market opened up the whole debate on public and private water transactions and consequences and sustainability of the groundwater economy (Llamas and Martinez-Santos, 2004; Shah, 2009) at large. While speaking about the structure, nature and importance of this informal groundwater market Shah 2000 mentioned that such markets have made the benefits of groundwater access available to an estimated 50–70 million-smallholder farmers, who would have been unable to invest in their own tubewell. Evidences are quite strong to notify that access of groundwater through such market has positive influence in raising irrigation intensity, farm productivity, cropping pattern, yield and income. In gangetic track of West Bengal and Bangladesh cropping pattern changed from rainfed paddy and jute to irrigated boro rice cultivation in the month of January through June (Rahman and Ahmed, 2008; Saidur *et al.*, 2012, Qureshi *et al.*, 2015; Ray and Ghosh, 2007).

Although the impact of intensive boro cultivation or groundwater dependent sugarcane and banana cultivation has its strong share of criticism (see Ray and Ghosh, 2007) it has able to change the agricultural scenario of West Bengal and other states of India.

Two things started emerging soon it was realised that first, the appropriation of this resources is still not properly developed in certain areas, and so it is good news. While on the other hand not all the farmers has been benefitted equally by fast development in groundwater. Arguably the institutional arrangements in groundwater based economy is socially and economically embedded that takes into consideration

economic understandings and moral values (Dubash, 1998). While their embeddedness in social structures may ensure stability in exchanges, and filter monopoly of big and powerful players, this also meant that groundwater market is highly segmented and often built on existing inequalities of landownership, caste and class dynamics (Bouarfa and Kuper, 2007). The axes of differentiation are more prominent in the peripheral areas of the big cities marked by abstraction, flows, transactions and mining of the groundwater resources for multiple purposes. To what extent such diversification of uses of this asset helps to reduce poverty should be analysed at the context of changing landuse, ownership, aspirations, and opportunities of the periurban community.

### **III. Understanding periurbanity and groundwater use**

The classical theoretical models of Walter Christaller (1933), Colby (1933), Harris and Ulman (1945) in the early decades of the present century gave a simplistic model of growth poles and urban diffusion where cities became the determining factors for evolution of fringe. They stipulated explicitly or implicitly that the city is the source of growth and market mechanisms played the determining role to disperse the growth impulses to the rural hinterland and thus balances the regional development in any country. Urbanisation process in the developed world manifests such theoretical underpinnings. Periurban areas of the developed world thus are a zone of reverse urban or of rururbanisation processes. American 'suburbs' are an extended, monotonous residential middleclass American colony resulted from carefully planned counter urbanisation process (Sosea, 2013). While the French suburbs are transitional zones designating a medieval judicial notion, an extramural territory, distinct from the faubourg (Derruau, 1996), but depending on the centre, occupied by middle class and poor groups in uneasy competition (Sosea, 2013). Contrary to this, periurbanization process, mostly belong to newly urbanised countries of the Third World, mainly Latin America, South Asia and Africa. Periurban interface in these countries are often blurred territory emitted from haphazard, forceful (Sridhran, 2006), urbanisation process often without a proper settlement strategy by the government and many a times hovering on its colonial past. It is a result of extensive, uncontrolled urban growth that lacks structural, functional, ecological and psychological cohesion. Howard Spodek (2013) in his article on 'City planning in India under British rule', narrates the

evolution of native and white neighbourhoods in several Indian cities. Elite biased planning process in the post-independence era has followed the similar trend where growth has remained largely city centric.

The concepts, interpretations and identifications of periurban areas thus differed across countries and has changed over time (Mbiba and Huchzermeyer, 2002). Periurban literature has given variable terminology to it, reflecting the vagueness of space. Such variation not only informs towards a micro analytical approach but also points towards the underlying ambiguity. Researchers often argued that precise definition and map of periurban areas are often not possible. As stated by Clark 2006, a precise definition and map are not possible, but generally, the urban fringe means those areas just beyond the built-up part of a city, although still close enough to the city to be subject to intense development pressures. The fringe is not a line on a map; it is a zone of radially diminishing urban-style activities. It is the existence of a fringe that prevents to distinguish the urban from the rural, since the fringe has features of both. Yet, it is more than an amalgam of the two; the fringe is a distinctive place with features of its own. It is, above all, a place of heightened land-use conflict, uncertainty and profit potential, hence its interest to geographers. Albeit, differences in the way such process operates in developed and developing world, unprecedented growth in the numbers of “transitional areas” interspersed with rural areas, and the changing nature of state intervention for development and poverty alleviation in the light of structural adjustment programmes have particularly influenced the resource utilisation capacity of the megacities.

Today peripheries are no longer been seen as a repository of various geographical and functional phenomena (Sosea, 2013) but a self-contained entity quite distinct from its rural and urban counterparts. They exhibit specific characteristics that make their governance a distinctive challenge. They are constructed primordialism (Arovindo, 2006), determined by urban metabolism. They are challenging (Sosea, 2013), degenerated (Kundu *et al.*, 2002), transitory, subsidiary, movable, vulnerable, fast paced, ephemeral space that lacks adequate politico-administrative jurisdiction (Milbert, 2006).

In case of India some amount of administrative recognition has been done in

73rd and 74th constitutional amendments. They have granted civic status to these transitional areas by constituting Nagar Panchayats or Town Panchayats in India, although most Indian states have yet to accept them (Shaw, 2005). Consequently, most of these areas continue to be governed by gram panchayats. While talking about governance and institutions of these “transitory areas”, Roy 2006 noted that institutions failed to maintain the balance between the policy prescriptions and ground realities. They are often saddled with responsibilities that are neither within their jurisdiction nor they are equipped to handle. The periurban areas also gets recognised by the presence and growth of census towns in India. This category of settlement is dynamic in nature and has three distinct features, population of 5,000 or more; a population density of 400 persons per square kilometre; and 75 percent of the male workforce in the non-agricultural sector. Sivaramakrishnan *et al.* (2005) and Denis and Marius-Gnanou (2011) found that there are few settlements which despite having density population of more than 10,000 inhabitants, are not been classified as urban by census of India. This clearly shows the ambiguity in identifying and mapping periurban areas based on few orthodox criteria. Kundu explains this area as degenerated peripheries characterised by fragmented holdings, loss of ecological habitats, pollution, weak institutions and poor governance (Kundu, 2002, 2011; Hepcan *et al.*, 2011). Sosea (2006) while describing the periurbanisation process in Romania narrates about a chaotic, disharmonic development of peripheries favoured by the unclear legislation and the industrial collapse. While the proponents of urban fragmentation thesis – or, splintering urbanism thesis (Graham and Marvin, 2001) consider periphery as model enclaves of opportunities. While explaining the urban sprawl of the global city of Hyderabad in India Keneddy and Zerah 2008 writes about the parks and premium spaces with high level of services, lying in sharp contrast with the surrounding villages. Her work provides an exemplary case for highlighting increased spatial differentiation as well as the strong heterogeneity of local society. These two interpretative frameworks are not necessarily exclusive of each other, but demonstrates the intricacy of the political and societal vision of the city (Dupont, 2007)

Thus the best these in-between areas can be identified with high dependency on groundwater, flows of goods and services, diversified livelihoods, mixed landuse, changing aspirations, opportunities, exclusions and sometimes weak governance

structure. Large scale dependence on private bore wells as principal means of water supply for drinking and agricultural purposes for the periurban residents testify to the lack of formal service system in these areas. As observed in the Delhi Capital Region groundwater is used for irrigating nearly 50 percent of the geographical area. Erratic rainfall, disappearance of the surface water bodies has often results in its low recharge. Level of groundwater development thus surpassed its replenishable limit with falling water-table at an alarming rate (Rai and Kumari, 2012). Akther *et al.* (2010) in their study in the city of Dhaka, Bangladesh reported similar observations where spatial and temporal fluctuations of groundwater level been observed due to decline in recharge and increase in abstraction. Ray and Ghosh 2007 while talking about the groundwater based boro (summer) paddy cultivation in West Bengal mentioned rapidly falling groundwater table in north and south 24 Pargana districts which forms part of the Kolkata metropolitan. They further stated that extensive withdrawals of groundwater for cultivation of summer paddy has resulted in ‘declining groundwater levels and this is doubted to be one of the causes for occurrence of arsenic beyond the permissible limit in underground sources of water’ (Ray and Ghosh, 2007). Gangapuram *et al.* 2015 observed intense groundwater irrigation in lower Krishna basin of Telangana state of India. They reported that rabi crop (November–March) is completely dependent on open wells that are 10–20 m deep or bore wells that are 80–100 m deep installed with submersible pumps. By using Standardised water-level index (SWI) they assessed groundwater recharge–deficit between pre and post monsoon in Peddavagu and Ookachetti vagu watersheds in lower krishna basin. Their study concluded that except in meteorological draught years the basin shows good potential for groundwater exploitation for meeting water demands (Ganapuram *et al.*, 2015).

#### **IV. Theoretical approach and analytical framework**

Understanding of the aforesaid complex interrelationships across ownership, claims and diverse usage of groundwater resources and resultant outcomes at the wider context of periurbanity needs an integrated approach. The study adopts Sustainable Livelihoods Approach (SLA) to assess how periurban households are sustainably managing their groundwater resources, making strategic choices and responses to shocks and stresses, so as to enhance livelihoods, income and welfare in the wider context of structural and



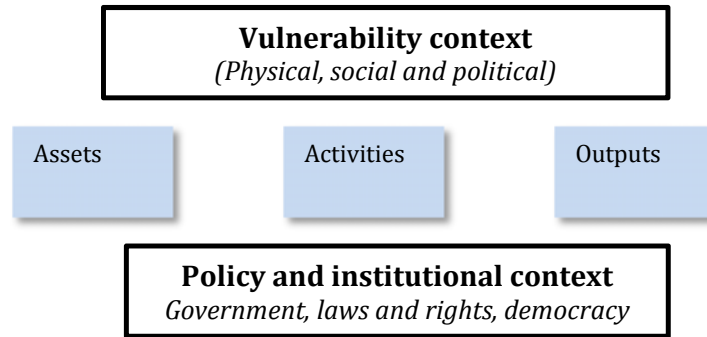
historical process change (Haan and Zoomers, 2005; McLean, 2015). SLA purports to be a comprehensive, all-encompassing actor oriented research perspective that puts lives of the poor people at the center of the development interventions. It informs policy makers and practitioners about the support people needs, which are more meaningful to their daily lives, as opposed to ready-made, interventionist instruments. Albeit, theoretical and methodological challenges, SLA has been widely used for designing many fisheries, livestock, forestry, rural development, and poverty alleviation investment projects and programs, as well as for monitoring stakeholder participation by the Food and Agricultural Organisation of the United Nations (FAO). The reasons for applying SLA in the periurban research are several, first periurban is a highly dynamic and transitory space marred with multiple stressors of encroaching urbanisation and withering rurality. Such complex structural and historical process change make periurban community more vulnerable to shocks, stress and seasonality compared to its rural and urban counterparts. Second, periurban is a lived space of diverse actors with different endowments, entitlements and interest to resource (groundwater, land) use. Livelihoods are much more diversified here and often accentuate the already existing social differentiation. To what extent households successfully choose trajectories of upward mobility determines its position in the poverty ladder. General categories such as 'the poor' do not exist for a periurban area. It is always flexible and fuzzy depending on social relations, institutions and organisations. The point of departure is that agriculture or farming might not be sufficient for survival for a poor periurban household. Poor household depend on a diverse portfolio of activities and income sources mediated by social norms, values, relations, ties and networks. To what extent such process will accentuate rural inequality by withdrawing critical resources or a safety valve for the poor depends on the way people can exploit livelihood opportunities in their favour. Third, periurban space presents fencing-in of opportunities (Haan and Zoomers, 2005) where households/actors react collectively to access a particular resource in such a way that it hinders accessibility of others. This creates social exclusion and categories of eligible and ineligible. For instance in periurban Hyderabad, India, informal groundwater market are strongly operated and controlled by a particular caste group, called Reddys (SaciWATERs, 2016). Such social closure creates barriers for other groups to enter into

the business. Similar evidences from West Bengal and Bangladesh shows that intensive tubewell based boro paddy cultivation has increased farm income and productivity for selected rich farmers pushing the poor down in the poverty ladder. SLA provides a holistic tool to analyse these complex interactions and responses of conflicting and co-operating actors in managing groundwater resources. Fourth, the approach provides an improved understanding of the policy (micro-macro) interventions require in periurban context towards sustainable management of the groundwater resources.

SLA derives from the work of Robert Chambers (at IDS) and Gordon Conway (at IIED) in 1992, who argued for the creation of livelihood strategies (for rich and poor) that accounted for their long-term impact in terms of maintaining the natural resource base for use by others and future generations, whilst being resistant to external shocks and stresses (Toner, 2003; Haan and Zoomers, 2005; McLean, 2015). Chambers argued that not sustainability, but security, income and tradeoffs between vulnerability and poverty should form the crux of development and poverty reduction strategies. It got its wide scale popularity in the beginning of the new millennium, when the so-called Sustainable Livelihood Framework was strongly promoted by the Department for International Development (DFID), the British state development cooperation Agency. Figure 1 gives a simplified explanation to this approach. The framework consists of three clusters Asset, Activities and Outputs. Each of these clusters is influenced by Vulnerability context (physical, social and political) and institutional context (formal, informal, rules, laws, acts, policies). Here assets can be natural, social, human, financial, physical (Carney, 1998; DFID, 1999). Baumann and Subir (2001) suggested political capital should be given equal status with other capital assets, while Amekawa 2011 suggested cultural asset to be included in the framework. However Tonner 2003 argued that a sound definition of social capital would necessarily include a consideration of power and political relationships. Assets can be private or common property, rented, borrowed, grabbed, stolen or conquered. What matters is that the poor have access to them when needed, so that their endowment changes into entitlement" (Geiser *et al.*, 2011). The things people do in pursuit of a living are referred to in the livelihood framework as livelihood 'activities'. The risk factors that surround making a living are summarised as the 'vulnerability context', and the structures associated with government (national and local), authority, laws and rights, democracy and

participation, and NRM institutions are summarised as the ‘policy and institutional context’.

**Figure 1: Framework of Allis and Allison**



Source: Ellis and Allison, 2004.

Both the context and structures has a significant role in not only influencing the activities but also getting influenced by people activities. People’s livelihood efforts, conducted within these contexts, result in outcomes: higher or lower material welfare, reduced or raised vulnerability to food insecurity, improving or degrading environmental resources, and so on. Access and claims became central to the approach. Thus livelihood approach focused very much on how people organised their lives, more on opportunities and more on agency, rather than concentrating on their impoverishment as in the 1980s household and survival studies used to do’ (Haan, 2012). The approach found its application in the work of number of donor agencies like UNDP (Hoon *et al.*, 1997), NGOs like Oxfam and CARE and civil societies (Solesbury, 2003). “The Society for International Development (SID) in Rome also started a Sustainable Livelihoods Project, which originated from SID’s grassroots initiative programme and focused on the question of how to increase the effectiveness of grass- roots and other kinds of civil society organisations” (Haan and Zoomers, 2005).

Significant research on SLA continued in the work of Carney and Scoones at IDS where the institutional processes (embedded in a matrix of formal and informal institutions and organisations) were made central in the framework. Scoones takes livelihoods define by Chambers and Conway as means of gaining a living, including livelihood capabilities, tangible assets, such as stores and resources, and intangible

assets, such as claims and access (Chambers and Conway, 1992). The term livelihood attempts to capture not just what people do in order to make a living, but the resources that provide them with the capability to build a satisfactory living, the risk factors that they must consider in managing their resources, and the institutional and policy context that either helps or hinders them in their pursuit of a viable or improving living (Scoones, 1998; Nicole, 2000; Ellis and Allison, 2004). This definition was widely used by several researchers using SLA subsequently (Ellis, 2000).

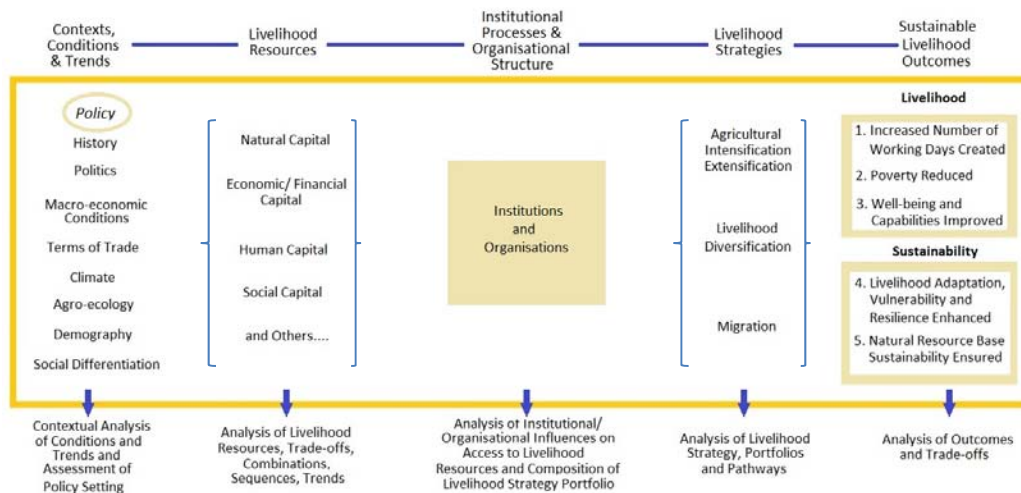
The key aspects of this definition are capabilities, assets and the multiple options that individual pursue to generate income for survival. The concept of capability has been borrowed from Sen and refers to the ability of individuals to realise their potential as human beings, in the sense both of being (i.e. to be adequately nourished, free of illness and so on) and doing (i.e. to exercise choices, develop skills and experience, participate socially and so on). Assets refer to number of components ranging from different types of capital to claims and access. Activities entails to diversified strategies that households undertake in order to survive and improve their income. Each of these aspects has undergone modifications over time, for instance assets, which started with physical and human capital, also included natural, financial, social and political. However the most critical component of the asset ownerships and diversified activities as stressed by livelihood researchers is access, which in turn underpinned by rights and power (Haan and Zoomers, 2015; Amekawa, 2011).

Different theoretical concepts underpinning such understanding of assets led to the emergence of divergent schools of thoughts. Formal livelihood research focused on assets pentagon, activities and outcomes (Scoones, 1998; Ellis, 2000; Ellis and Allison, 2004; Toner, 2003; Donohue and Biggs, 2015; Misra, 2009; Shivakoti and Shrestha, 2009). While alternative thoughts on livelihood gave rise to 'hybrid research collectives' focusing on power dynamics within and between households (McLean, 2015; De Haan and Zoomers, 2005; Mehta *et al.*, 1999; Rigg, 2007, Jakimow *et al.*, 2013). In both conventional and alternative livelihood literature access forms a crucial element influencing assets ownerships and livelihood strategies. However they differ with the interpretation of access and the role of rights, power and gender. Chambers and Conway defines access as rules and social norms that determine the differential ability

of people to own, control claim and make use of resources (Scoones, 1998). It gets mediated by stress, shocks, social relations, and institutions embedded in vulnerability and policy context.

Although there is diversity in the interpretation of this approach (Hussain, 2002), it shares a basic unit of analysis in households (Ellis, 2004). SLA with its household focus believed to bridge the gap between micro-economics, with its focus on the atomistic behaviour of individuals, and historical-structuralism, which focused on the political economy of development (Haan and Zoomers, 2005). The households are selected communities, usually chosen for their representativeness of a particular region or livelihood dilemma. For instance, Ahmed *et al.* in their study of fresh water prawn culture in *gher* system of North West Bangladesh chose households from different livelihood systems like prawn–fish–rice, prawn–fish, prawn–rice and prawn. The sample size depends on the capacity and resources of researchers, along with the willingness and availability of the participants.

**Figure 2: Sustainable rural livelihoods: A framework of analysis**



Source: Scoones, 1998.

The approach swathes multiple frameworks that have been developed by various researchers and professional institutions as inductive products of empirical researches (Amekawa, 2011). Sustainable Livelihoods literature surfaced continuum with some using SLA, in qualitative research, to understand assets ownerships and livelihood strategies, others choosing nuanced, detailed contextual readings of livelihood realities.



Following section analyses some of SL frameworks that have emerged from this approach over time, both mainstream and hybrid research collectives' to identify, or develop one, that can best interprets the complex relationships between livelihood and groundwater management in a periurban space. Figure 2 explains Scoones framework of sustainable livelihood.

The framework starts with contextual analysis of historical, social, economic processes that determines the combination, clustering and sequencing of households natural, economic/financial, human and social capital. The question that framework attempts to answer is that given a particular context (of policy setting, politics, history, agro-ecology and socio-economic conditions), what combination of livelihood resources (different types of 'capital') result in the ability to follow what combination of livelihood strategies (agricultural intensification/extensification. The framework identifies four key assets, amenable to empirical investigation, playing major role in sustainable livelihoods and poverty reduction. Natural capital as an asset is defined as natural resource stocks (soil, water, air, genetic resources etc.) and environmental services (hydrological cycle, pollution sinks etc.) from which resource flows and services useful for livelihoods are derived. Economic or financial asset includes cash, credit/debt, savings, and other economic assets, including basic infrastructure and production equipment and technologies). Human capital refers to the skills, knowledge, ability to labour and good health and physical capability important for the successful pursuit of different livelihood strategies. Social capital refers to the networks, social claims, social relations, affiliations, associations upon which people draw when pursuing different livelihood strategies requiring coordinated actions.

However the most important aspect of Scoones' framework is institutional processes (embedded in the matrix of formal and informal institutions and organisations), which mediates the ability to own, claim and utilise assets, opt diversified strategies and achieve (or not) desired outcomes. Scoones' SLF takes an institutional lens to assess the role of institutional processes as central in determining household's ability to combine resources and carry out livelihood strategies to achieve (or not) a particular outcome. They are critical in defining the types of bargaining and decision making that take place at the household and community level. Scoones defines institutions (both formal and informal) as regularised practices (or patterns of

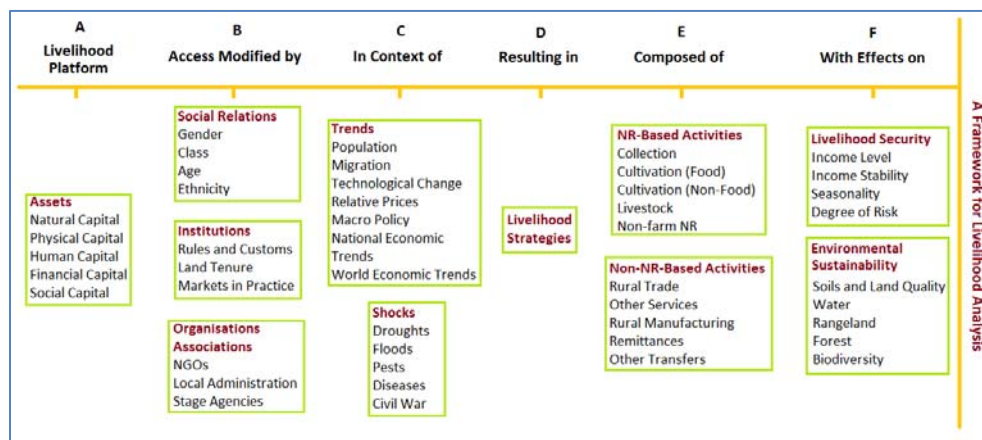
behaviour) structured by rules and norms of society, which have persistent and widespread use (Scoones, 1998). It thus provides a broad context that creates restrictions/barriers or provides opportunities in accessing assets, forming strategies and deriving desirable outcomes. He argued that policy operates rather mechanistic way influencing people's choice of livelihoods strategies (Shankland, 2000). The framework identifies five indicators of sustainable livelihoods; viz. creation of working days, poverty reduction, well-being and capabilities, livelihood adaptation, vulnerability and resilience and natural resource base sustainability.

Three broad clusters of livelihood strategies are identified in the framework, agricultural intensification (more output per unit area through capital investment or increases in labour inputs)/extensification (more land under cultivation) livelihood diversification (diversify to a range of off-farm income earning activities), and migration (move away and seek a livelihood, either temporarily or permanently, or elsewhere). In pursuing a particular portfolio of livelihood strategies, there are trade-offs faced by different people with different access to different types of livelihood resources. Depending on who you are, differential access to different types of capital may have positive or negative implications in terms of the success or otherwise in the pursuit of a sustainable livelihood. Tradeoffs also happens in the responses and strategic choices.

His argument is based on rational choice model where people take strategic decisions as a direct response to policy and institutional change (Toner, 2003). Heaping social relations, institutions and organisations together as part of the 'institutions' and one sided approach of looking the impact of these rules and norms on the access as evident from Scoones framework led to subsequent research on understanding the institutions itself and also to see how livelihood in turn reconfirm and reshape institutions. In this direction the work of Ellis, 1998, 2000, 2004 becomes critically important. Frank Ellis, 1998 from Overseas Development Group of the University of East Anglia highlighted the importance of multiple, diverse character of livelihoods and state society interface in the SLA framework. His work is considered to be one of the significant milestones in the research of sustainable livelihood. Ellis framework (figure 3) starts with 'assets owned controlled, claimed, or in some other means accessed by the household' (Ellis, 2000). And like Scoones, Ellis also considered five kinds of assets. Substitution capabilities within and between these assets are important restraints to

shocks and stress. Substitution within human capital has been elaborated by Moser, 1998 where examples have been given of changing domestic and wage labour with changing circumstances. Knutsson, and Ostwald, 2006 explained the complex process of asset substitution and complementarity in choosing particular livelihood strategies. They argued ‘when rural people adopt new livelihood strategies in response to changes of the vulnerability context or transforming structures and processes, the value of some assets decrease while others increase. This means that in order to avoid increased vulnerability, people often need to transfer the value of one asset to another. This transfer can take the form as either (i) direct substitution (such as when financial capital is used to buy a motor vehicle), or as (ii) complementarity (such as when increase of education level in a family directly increases social capital), and finally (iii) the more indirect and complex flows of capital value, which takes place when substitution or complementarity is not possible (such as when decreasing value of agricultural land is not directly substitutional or complimentary to the increasing value of social capital but can be transferred into social capital through a series of complex and flexible transformations). However, the degree to which the value of a capital can or needs to be transferred to other capitals, differ from capital to capital depending on particular contexts and institutional constraints’ (Knutsson, and Ostwald, 2006). Assets both facilitate and are facilitated by diversification (Ellis, 2000). For instance human and social capital can enhance the possibility of diversification while at the same time instrumental in assets procurement.

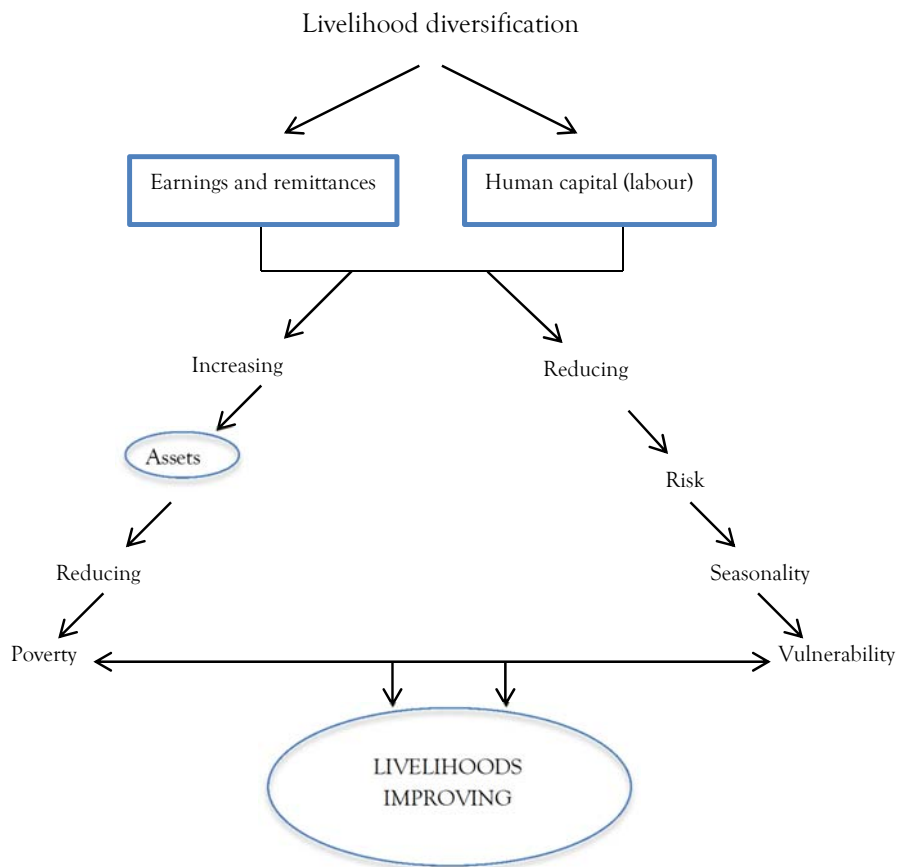
**Figure 3: Sustainable livelihoods framework of Ellis**



Source: Ellis, 2000

The most significant part of Elli’s framework is livelihood strategies (figure 4). His livelihood diversification that forms the central part of the framework assumes a rational choice model where people choose livelihood strategies to ameliorate the riskiness and overcome the consumption smoothing problem created by seasonality (Ellis and Allison, 2004). Based on empirical evidences from Africa, Ellis mentioned that Livelihood diversification has a positive feedback on rural poverty reduction. It helps to lessen the vulnerability of the poor to food insecurity and livelihood collapse; it can provide the basis for building assets that permit individuals and households to construct their own exit routes out of poverty; and it can improve the quality and sustainability of natural resources that constitute key assets in rural livelihoods. Figure 3 shows the positive effect of livelihood diversification as explained by Ellis and Allison, 2004.

**Figure 4: Positive attributes of livelihood diversification**



Source: Ellis and Allison, 2004

Another important aspect that forms an important dimension of Ellis work is 'mediating processes' as explained by figure 3. While explaining social, economic and policy context unlike his precedors like Scoones and D. Carney, that heaped relations, rules and organisation into one, Ellis made distinctions between social relations, institutions and organisations on the one hand, and trend and shock factors on the other (figure 3, column B).

To him social relations comprises of gender, caste, class, age, ethnicity, and religion. Institutions are formal rules and conventions and informal codes of behavior like laws, property rights (land tenure arrangement, groundwater ownerships) and markets (shallow tube well irrigation market). Organisations as distinguished from institutions are groups of individuals bound by the purpose of achieving certain objectives like government agencies, NGOs, associations and private companies (Ellis, 2000). Livelihood strategies hint at a direct causal link between policy and action, which potentially denies full engagement with the complexity of the linkage (Toner, 2003). Ellis and Allison, 2004 mentioned "migration, mobility, flexibility and adaptability are downplayed, ignored, and sometimes blocked by policy and institutions; whereas these are the very attributes of diverse rural livelihoods that can lead in the end to stronger rather than declining rural livelihoods, and improving rather than degrading natural resources" (Ellis and Allison, 2004).

The importance of shocks and trends (column C) as exogeneous factors remained same as Scoones. Trends can be fortuitous or adverse having locational connotations. Thus trend of increasing population density in periurban areas has positive implications on the labour market in manufacturing sector. Rapid spread of tubewell technology, flat electricity tariff have helped in mushrooming of tubewell irrigation in south Asia. Shocks represents in figure 3 as droughts, floods, pests, diseases and civil wars. Shocks destroy assets directly or erode them indirectly. Both shocks and trends have widespread impacts on assets and livelihood viability of the households and individuals to whom they occur.

Although these authors have given the livelihoods approach the necessary conceptual foundation to separate it from an otherwise mechanical and a-political 'transforming structures and processes' approach, it was argued that behavior and



power dynamics have been largely missing from the framework (Jakimow *et al.* 2013, Haan and Zoomers, 2005). SLA assumes individuals act rationally according to their material conditions and access to forms of capital, paying scant attention to the ways their cognitive frames influence livelihoods (Jakimow *et al.*, 2013). SLA 'focus on opportunities than on constraints, more on actor's agency than on structure, more on neutral strategies than on failed access due to conflicts and inequalities in power' (Haan, 2012).

The importance of historical experiences and insights in shaping household's response to shocks was informed by Bourdieu, 1990, De Haan and Zoomers, 2005; Mehta *et al.*, 1999; Rigg, 2007. Strategic choices of SLA was arguably debated by hybrid collectivist theorists putting power as the central notion. Discursive argument on incorporation of power as the critical mass upon which livelihoods depend reflected in the works of Haan and Zoomers, 2005, Jakimow *et al.*, 2013, McLean 2015. Livelihood choices according to them are never strategic, deliberate or conscious. 'In many cases there is a close link between a household's strategy and its history' (Haan and Zoomers, 2005). Zommer (1999) considered household strategy not to be a mere reflection of intentional or unintentional behavior, but are often multilayered. Assets are not always used rationally or economically even if the opportunities to do so are there. Whether a household will remain poor or be able to make livelihood choices to become rich depends on its location, shared experience, knowledge, insights, interests, prospects, and interpretation of the context (Arce and Hebinck, 2002; Nooteboom, 2003). Different social groups, having similar experiences and dispositions, exhibit regularities of livelihoods, resulting in what they call livelihood pathways. However social differentiation, power relations and institutional process that determine individual or community's livelihood pathways are dynamic and changing, and there is an inherent role for actors in shaping and influencing these changes' (Jakimow *et al.* 2013). Thus the context and processes as depicted in the SLA has taken to a new dimension through political ecology lens.

In livelihood pathway analysis it is considered that people does not necessarily choose their own living but emerges out of past action, beliefs, needs, aspirations and decision made within specific historical and agro-ecological conditions and are

constantly shaped by institutional and social arrangements. While explaining livelihood pathways Han and Zoomers argued about livelihood trajectories as an analytical construct to unravel the historical route of livelihood choices. In other words livelihood trajectories helps to understand why certain choices were never considered irrespective of its prospects at individual and community level. In the study of livelihood trajectories power thus assumes a greater significance where mapping of power, starting from 'power within', via 'power to' and finally to 'power over' is analysed. Study of power relations that exist in various networks and different levels are further stressed upon by Amekawa, 2011 in his integrated model of sustainable livelihood.

## **V. Framework for the socio-economic system mapping**

Above discussion provides a rich base to construct a framework that can explain the dynamic relations between groundwater management and livelihoods in a periurban context. Figure 5 shows the framework for socio-economic system mapping. The mapping will essentially focus the inter-linkages across assets, activities and outputs as highlighted in the figure 4. While the mediating processes like policy and institutional context will be borrowed from institutional mapping and groundwater aquifer, rainfall, temperature, salinity, arsenic will be borrowed from hydro-geological mapping. Largely adopted from the Ellis work the framework starts with assets (block A) owned, controlled, claimed and accessed by households.

Groundwater forms the Natural Capital (NC) which is both consumable (drinking and domestic) and a productive (irrigation, fisheries, industries etc.) asset. Groundwater as a natural asset is not static and when gets combined with other forms of human and physical asset endowments that household own and can access, enhances or augments its capacity. Physical capital (PC) comprises assets that are created for groundwater irrigation. It includes farm-based assets like landholdings, shallow and deep tube wells, submersible pumps, boring, networks, canals/ *Khals*, labour (family or hired) that gives power to irrigate, collect water from long distance etc. Physical assets like roads are critical for movement of people, goods, services and information between villages and the cities. Power lines determine the intensity of groundwater irrigation. Availability and supply of electricity has enormous impact on location of manufacturing industries in periurban areas. Water pipelines are also significant asset in a periurban

context. Water pipelines has multiple effects on periurban livelihoods by saving cost of vended water, avoidance of illness and disease etc. Human Capital (HC) incorporates skills, knowledge, ability to labour, good health, education and awareness. Human labour is very much important with respect to household or medium to big manufacturing industries, construction works, waste water fisheries, paddy cultivation etc. The importance of household labour becomes all the more significant in a periurban context where agricultural labour market is limited, household size is large, migrated population is substantial. Financial Capital (FC) is the stock of money to which households has access. Credit facilities are crucial for groundwater irrigation in small farm economy of periurban Kolkata and Khulna. Short and long term credits are required for the purchase of seeds, fertilisers, insecticides, pesticides, electricity, diesel, cattle-feed, repair of farm implements, wages to hired labourers and to meet the consumption needs of his family till the harvest of the crop. Medium and long term finance is required for buying cattle and implements, undertaking digging of wells or other minor irrigation works, and effecting substantial improvement to land, tube-wells, farm machinery and orchards, and the repay of old loans. Shah 2010 writes the flow of institutional credit has played a significant role in stimulating or impeding the development of pump irrigation in different regions of India. How financial capital determines access to safe drinking water can be seen in the study of Ranganathan *et al.*, 2009 in the peripheries of the city of Bangalore. The study reported that periurban communities have varying levels of willingness and ability to pay upfront contributions even within a particular income category. Since grossly dependent on depleting groundwater asset residents face daily coping costs of paying for private tankers, sinking borewells, time spent in complaining to zonal offices and gathering water, and on-the-side payments for enhancing access to and release of water.

Social Capital (SC) comprising of network, ties, associations, affiliations lobbies etc. that creates opportunities, helps removing social barriers or impedes access to other capitals. For instance, water markets and rental markets for pumpsets in north Bihar, India resulted into reverse tenancy (Wood, 1999). 'In a study of groundwater market in the north Arcot district of Tamil Nadu, Janakarajan (1998) found that the commercialisation of irrigation was associated with the harassment of water-buyers by water-sellers and a subsequent selling or leasing out of land by water-buyers to water-

sellers. Rawal 2002 in his study of the groundwater market in West Bengal mentioned about collective action, informal rules mediating the access to groundwater irrigation. Political Capital (PC) has been suggested by Ashley and Carney in 1999 and been included separately in the assets inventory. Periurban being a political hotspots power politics plays a crucial role in choice of livelihoods and thus justifies its inclusion.

While analysing the variability and vulnerability of asset ownership considerable attention will be given to analyse the how households sequenced, cluster, substitute these assets to create portfolio of livelihood strategies (Chambers *et al* 1981). Trends and Shocks (Block B) Policy and institutional (Block C) context mediates entitlements of assets ownerships across households. However there are wide number of barriers in asset ownership, and the strategic choice that the households make to attain sustainable livelihoods.

The Vulnerability context exemplified by trends and shocks (block B) shows the impact of population, migration, groundwater policy/acts, electricity tariffs, market prices of boro paddy, fresh water fishes (prawn, cat fish, Indian carbs etc.), groundwater drawdown, rainfall variability, temperature rise, salinity intrusion, arsenic pollution, iron contamination, floods, civil unrest, disease and pest in Gher and waste water aquaculture etc.

The axes of differentiation lie across social relations (Block C) (gender, caste, class, age and ethnicity) as depicted in block D. Mukherji (2006), Bhatia (1992) and Dubash (2002) while explaining the impact of privatisation of tubewell in Gujarat wrote that the benefits of unrestricted access to pump groundwater is disproportionately appropriated by the large-scale landholding farmers who have the capital to drill deeper, while the poorer farmers are thrown out of the race and come to depend on these big tubewell owners for their livelihood. Prakash (2005) has shown that poor and marginal farmers in the groundwater- scarce villages of North Gujarat are increasingly becoming sharecroppers, the terms of which are overwhelmingly in favour of the landlord, who also happens to be the owner of the water. In rural and periurban Bangladesh proliferation of tubewells does not confirms everyone's access to groundwater. While talking about how gendered waterscapes are produced, reproduced and challenged in Bangladesh Sulatana (2010) writes that government initiatives to

provide arsenic free safe drinking water supply arguably restricted household's access. Since most of the arsenic free deep tube wells are in public places like bazaars, mosques, and roadsides which are considered to be overtly public and masculine younger women and unmarried teenage girls may be forced to fetch unsafe water for their family from a closer source (Sultana, 2010). In a few instances where a safe tubewell was in the homestead of a poor family, they gained an unusual new power through the ownership of a safe water source in a landscape of poisoned tubewells (Sultana, 2010).

Institutions includes formal and informal rules in groundwater market, share cropping, share holdings, collective actions in managing groundwater and organisations in Kolkata includes Kolkata Development Authority, Public Health Engineering PHE, Gram Panchayat, SWIFT, CGWB. In Khulna KDA, KCC, KWASSA, Brac, DMS, Jagoroni Chakro Foundation (JCF), TMSS, Muslim Aid, Bureau Bangladesh, CSS Microcredit, CSS Health are important.

Following Ellis, livelihood activities are categorised into agricultural intensification (D) (more output per unit area through capital investment or increases in labour inputs) /extensification (more land under cultivation) livelihood diversification (diversify to a range of off-farm income earning activities), and migration (move away and seek a livelihood, either temporarily or permanently, or elsewhere). Agricultural intensification includes mono-cropping of boro paddy, commercial gardening, wastewater fisheries, and industrial use. Agricultural extensification includes gher cultivation and rabi cropping.

Livelihood diversification (Block D) includes engagement in manufacturing sectors including household units and medium scale industries, water vending for drinking and irrigation purpose, labour in construction industry, contractual labour in agriculture, and houses (maid servants), transportation sector (auto rickshaw driver), service sector, remittances, livestock etc. Migration will look into the historical account of partition of Bengal and resettlement of refugee in the study areas. Distressed migration from the coastal areas, migrants from the city core to the peripheries. While analysing the entitlements and livelihood activities considerable attention will be given to power dynamics. Through qualitative survey of FGDs and KPIs attempts will be made to capture the historical and structural process changes in the pursuit of

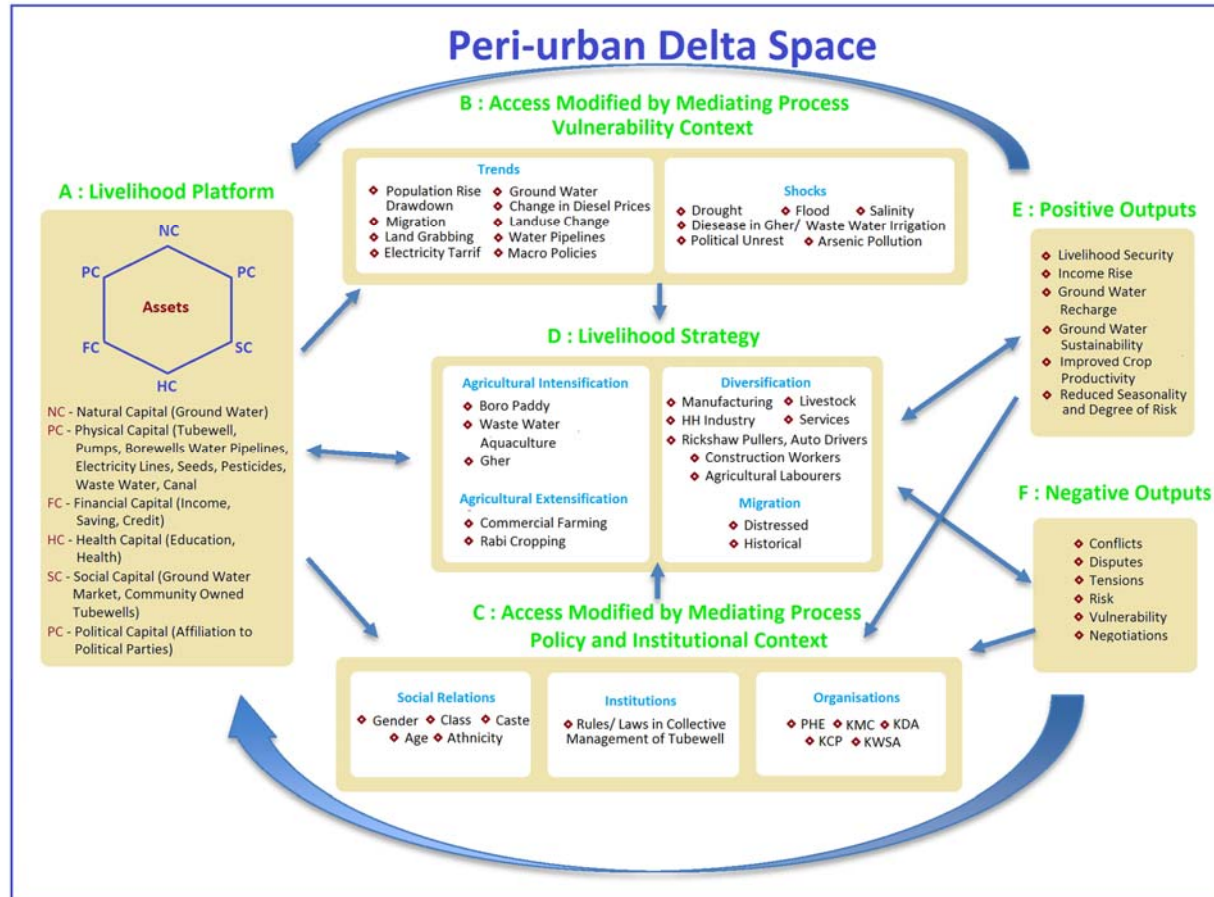
livelihood portfolio for particular households.

Livelihood strategies intended towards varied positive outcomes (Block E) like increase in farm productivity, incomes, access to drinking water, resilience and better adaptation to shocks and vulnerabilities. It can effect groundwater recharge, increase in biodiversity. However positive outcome of one households can be negative for the community or village as a whole. The portfolio strategies might often leads to negative tradeoffs, or negative impacts to other households. It is part of the policy makers to understand these processes and tradeoffs for making effective policy packages. For instance irrigation policy indulges into private investments whereas poverty reduction measures aims to reach out to the poorest. For political and technical reasons policy makers allows exemption from charges for the water drawn public tube wells and standpost.

Whether such portfolio combinations result in positive or negative change in relation to the range of sustainable livelihood outcome indicators thus forms the feedback loops. These loops feed into the micro interventions, macro policy formulations and asset ownership of the households.



Figure: 6 Sustainable livelihood framework adopted from Ellis (2000)



Source: Constructed by the Author.

## VI. Methodological tool

The research will use MGPAT, an adopted version of MPAT<sup>1</sup> to quantitatively measure the multidimensional aspects of ground water poverty and livelihood in a periurban context. This will be substantiated by focus group discussion and key person interviews to understand how different historical, socio-economic and politico administrative processes produces challenges of access/lack of access to service delivery and loss of livelihoods pushing the vulnerable further below the poverty ladder or reinforces opportunities by adding value to the change in the agricultural type, cropping pattern, irrigation water use. Detail of the indicators to be used for the survey is given in annex 1.

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<sup>1</sup> Developed by IFAD. Available at: <http://www.ifad.org/mpat>

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## Annexure

MGPAT, an adopted version of MPAT entails to measure the multidimensional aspects of ground water poverty in a periurban context. Originally MPAT can be measured in two ways-

1. Standardised MPAT
2. Context specific MPAT

In both the cases the components and subcomponents are aggregated through geometric average. Expert valuations are used for survey items and expert weightings for subcomponent aggregation. The critical difference between the standardized and context specific MPAT is that for later subcomponents can be modified, altered added by adding more questions to the original format for effective representations of context and issues. The questions should however be added at the end of questionnaire since the additions of questions anywhere else in the MPAT survey will likely to disrupt tools psychometric soundness and it will not be comparable across regions or countries. Hence MGPAT essentially adopts Context Specific MPAT where more subcomponents pertaining to groundwater, institutions livelihoods and periurban can be added. The weightages for the subcomponent will be context and region/country specific and obtained through consultations with experts, officers and community members. The expert valuations for the components given in the original MPAT design will be considered for comparative assessment between villages of periurban Kolkata and Khulna. While area specific weightages will be given to the subcomponents to understand the issues that needs attention of policy makers, donors and community members in each case. The survey will be conducted at household and village level. The sampling design should take into account the problem context across and within households to the village level. Since Gender is an important aspect of MPAT, the

study will mainstream gender analysis by undertaking gender disintegrated HH survey. To capture social and religious differentiation the HH belonging to different caste, economic and religious groups will be selected. Migration is an important element of sustainable livelihoods particularly in periurban context. This will be captured by selecting migrated households from the village.

MGPAT will have 10 components based on the original MPAT design. Marked in red are additional subcomponents tailored for the study.

S. no.	Component	Subcomponent	System mapping	Remarks
1	Food and Nutrition Security	Consumption	Socio-economic	This will cover the Human asset assessment of SLF. Gender disaggregated data will provide understanding across intra and inter household level
		Access Stability		
		Nutritive quality		
2	Domestic water supply	Quality	Hydrological, Socio-economic, Institutional	This will come under Physical and social capital of SLF. This goes both, as an asset owned by the households as well the security they want to achieve. Quality should capture <b>arsenic, salinity and industrial pollution</b> . Availability entails to <b>formal and informal service delivery</b> . Access should include <b>ability to pay for vended water</b>
		Availability ( <b>infrastructure</b> )		
		Access		
		<b>Rights</b>		
		<b>Networks</b>		
		<b>Power</b>		
<b>Decision making</b>				
3	Health and health care	Health status of the HH	Socio-economic	They forms part of the human capital of SLF
		Access and affordability		
		Healthcare quality		
4	Sanitation and Hygiene	Toilet facility ( <b>available and accessible</b> )	Socio-economic	This is also can be considered as part of Physical and Human capital and the wellbeing they like to achieve with increase affordability and awareness
		HH waste management		
		Hygiene practices		
5	Housing and Energy	Structure Quality <b>Structure quality of the small scale factors and</b>	Socio-economic	This is also can be considered as part of Physical capital and the status they want to achieve

		<p>HH industries</p> <p>Facilities residential and working place like small scale factors and HH industries</p> <p>Energy (residential and working place like small scale factors and HH industries)</p>		
6	Education	Quality, availability, access	Socio-economic	Forms part of Human capital and will use for gender analysis
7	Agricultural Asset (farm asset)	<p><b>Tubewell irrigation infrastructure</b> (shallow and deep, diesel and electrified and its network)</p> <ul style="list-style-type: none"> <li>-land tenure</li> <li>-labour arrangement</li> <li>-cropping pattern</li> <li>-Command area</li> <li>- fertilizer</li> </ul>	socio-economic	They form part of the physical assets and also covers the agricultural intensification/extensification in livelihood strategies of SLA
		- water quality	Hydrological	
		<p><b>Ownership, rights and policies</b></p> <ul style="list-style-type: none"> <li>- Private/government</li> <li>- Collective (alternate arrangements)</li> <li>- state groundwater act/tubewell irrigation policies</li> <li>- electricity policies</li> </ul>	Institutional and socio-economic	Part of social and political capital assets of SLF and also the institutional context that influences livelihood strategies
		<p><b>Groundwater Irrigation Market</b></p> <ul style="list-style-type: none"> <li>- Private and public</li> </ul>		
		<p><b>Gher system</b></p> <ul style="list-style-type: none"> <li>-land tenure</li> <li>-labour arrangement (owned/contractual)</li> <li>-finance/loans</li> <li>-availability of water</li> </ul>	Socio-economic, Institutional	Part of financial, political and social asset livelihood strategies institutional context

		-availability of inputs (seeds, fish larva etc), pesticides -political connection -power -network		
		<b>Wastewater irrigation</b> -quality of wastewater -labour (kinds and arrangement types) -market linkages -electricity/diesel pumpsets -social and political network -knowledge and awareness		
		Crops/livestock/fisheries - availability of water/fertilizer/manure/seeds/foods/labour for crops, and/or livestock/and or fish	Socio-economic	This include other miscellaneous livelihood options
		Agricultural labour	Socio-economic	
8	Non-agricultural asset	Employment and skill (assess the HH income earning potential from small business and skill service provision) <b>and income earned</b>	Socio-economic mapping	Part of human capital and social capital (hereditary knowledge and skill and/ through training programme) Livelihood strategies (HH industries like jari works, crackers manufacturing, small and medium scale factories owned or employed, government services, teacher, rickshaw pullers, auto drivers, maidservants, construction workers, petty business, water vendors etc.)
		Financial services (access and barriers)	Socio-economic	Part of financial asset
		Fixed asset and remittances	Socio-economic	Financial asset
9	Exposure and Resilience to Shocks	Degree of exposure	Hydrological, institutional	

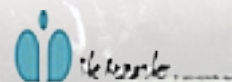
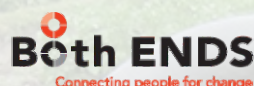
		Coping ability	Socio-economic Institutional	Livelihood strategies Wellbeing aim in SLA
		Recovery ability	Socio-economic Institutional	Conflicts and cooperation forming part of the sustainable outcome. It will also include institutional context analysis
10	Gender Equality	Food consumption	Socio-economic Institutions	Part of human and social capital. It is also a sustainable livelihood outcome
		Access to education	Socio-economic	Part of human and social capital. It is also a sustainable livelihood outcome
		Access to health care	Socio-economic	Part of human and social capital. It is also a sustainable livelihood outcome
		Access to water (domestic, irrigational)	Socio-economic	Part of human and social capital. It is also a sustainable livelihood outcome
		Access to land	Socio-economic Institution	Part of human and social capital. It is also a sustainable livelihood outcome
		Access to employment opportunities	Socio-economic Institution	
	Data to be collected for SLF but not part of the MGPAT	Migration	Socio-economic	This forms part of the livelihood strategies in SLF



## Shifting Grounds: Institutional transformation, enhancing knowledge and capacity to manage groundwater security in peri-urban Ganges delta systems

The project aims to build knowledge and capacity among local actors to support a transformation process in peri-urban delta communities in Bangladesh and India for a pro-poor, sustainable and equitable management of groundwater resources across caste/class and gender. This will be based on an improved understanding of the dynamic interplay between local livelihoods, the groundwater resource base, formal and informal institutions and links with nearby urban centres in Khulna and Kolkata. These two cities provide a good basis for an institutional comparison, being part of the same Ganges delta system, yet located in different countries.

Funded by the Netherlands Organisation for Scientific Research (NWO), the Shifting Grounds project is executed by a group of academicians, researchers and civil society organisations. Delft University of Technology (TU Delft) leads the consortium and SaciWATERS is the regional coordinator for the project. Other project partners are Jagrata Juba Shangha (JJS), The Researcher, Bangladesh University of Engineering and Technology (BUET) and Both ENDS.



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