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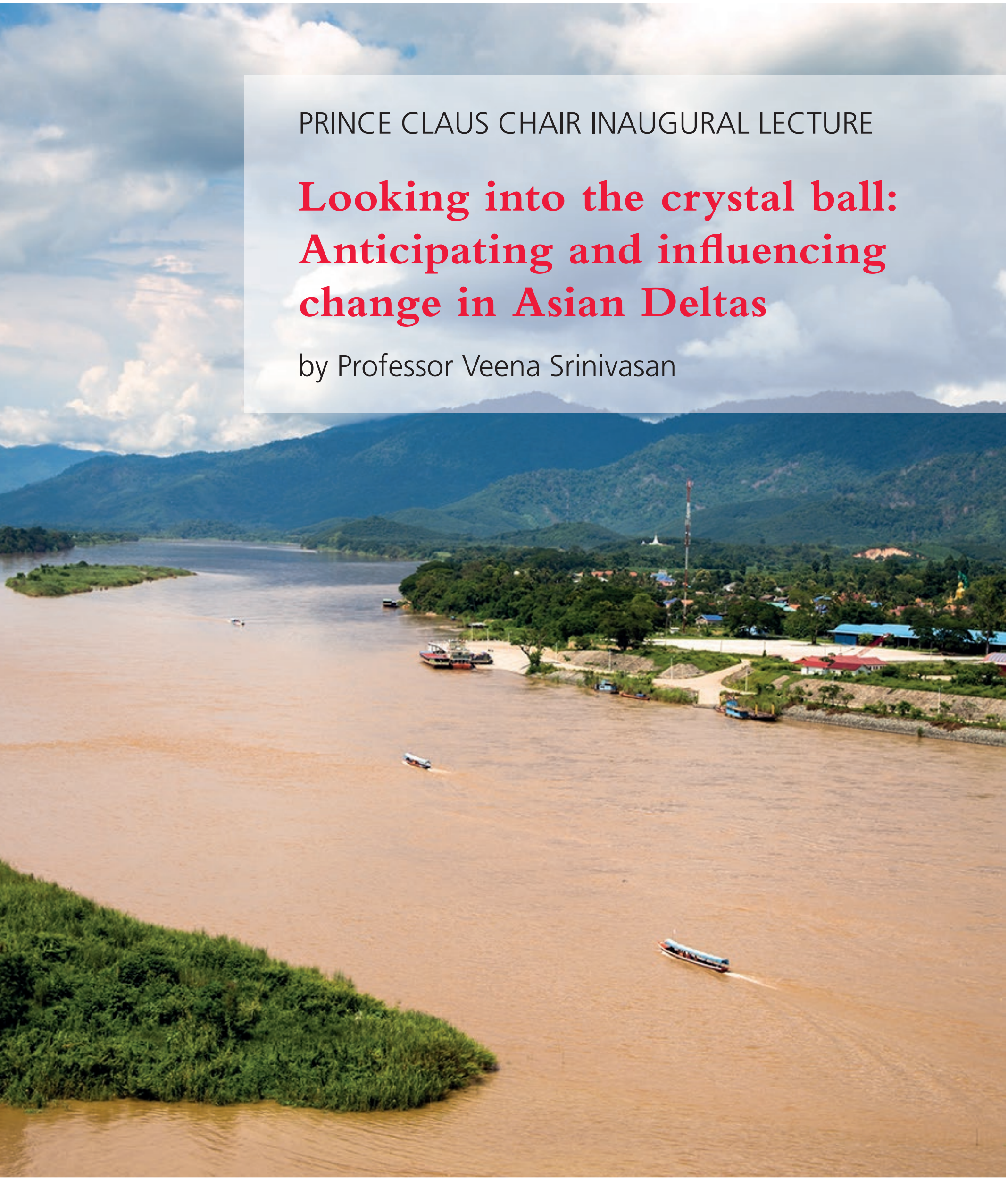

PRINCE CLAUS CHAIR INAUGURAL LECTURE

Looking into the crystal ball: Anticipating and influencing change in Asian Deltas

by Professor Veena Srinivasan

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Anticipating and influencing change in Asian deltas

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Inaugural address as Professor to the Prince Claus Chair in Development and Equity 2018/2020

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Rector Magnificus, Members of the Curatorium of the Prince Claus Chair in Development and Equity, distinguished professors, students, ladies and gentlemen,

It is my privilege to deliver my inaugural lecture as the Prince Claus Chair, in this historic venue, dedicated to the legacy of His Royal Highness Prince Claus his extraordinary dedication to issues of development and social justice.

The topic of this chairship, on the problem of anticipating and influencing change in Asian deltas, might appear unusual. What can a physical geographer, working on coupled human-water systems have to say about development or social justice? But serendipitously perhaps, it reflects how the discourse around development itself is changing. The Millennium Development Goals (MDGs), adopted by the UN in 2000 focused on poverty alleviation. By 2015, most countries had made significant progress towards these goals. But it became clear that development and sustainability could be in conflict (Sachs, 2012). The UN Sustainable Development Goals arose from this recognition: that human development cannot be sustained without equitable allocation and sustaining the natural resource base (United Nations, 2015).

This conflict is particularly apparent in the water sector. The history of water resources development is riddled with unintended consequences. Diversion projects affecting ecosystems or downstream communities, embankment projects depriving traditional fishing communities of their livelihoods (Sahani, 2019), or policies encouraging development of groundwater resulting in overexploitation and drying streams (Srinivasan et al., 2015). These unintended consequences arise from a failure to see the bigger picture and hidden cause-effect linkages. Sometimes the negative outcomes are conveniently blamed on global climate change even when the causes are local. This is not to say that climate change is not *the* major challenge of our time, just that it is not the sole driver of all changes in a landscape (Lele et al., 2018); in developing economies, where urbanisation, industrialisation, deforestation and agricultural intensification are occurring simultaneously, the challenge is "everything change".

My lecture today specifically describes the Cauvery Delta, in Southern India, as a case study of how human societies have shaped landscapes and in turn been shaped by them. Using evidence from past research, I hope to convince you that each actor in the system, acting within the confines of their knowledge and interests makes decisions that together could trigger unsustainable and inequitable outcomes. I will try to answer two questions. First, if we were standing in 1970 today with a crystal ball, would we have been able to imagine how the region would look half a century later? Second, knowing what we know today, could we do better in anticipating change? And if so, how could we take a more sustainable and equitable transition pathway.

The past: How to share a river

The Cauvery delta, located at the mouth of the 80,000 sq. km Cauvery river basin, lies at the epicentre of a 150 yearlong inter-state dispute. Riots over the Cauvery delta have claimed dozens of lives and inflicted billions of dollars of damages. The river, which has its origins in the Western Ghats mountain range, is shared by four states, but the dispute is mainly between the state of Karnataka (the erstwhile princely state of Mysore) and Tamil Nadu (the erstwhile British Madras Presidency).

Most of the flow into the river is contributed by the high elevation, biodiversity rich Western Ghats mountains which have rainfall as high a 6000 mm annually. The rainfall varies spatially. The Cauvery flows through a semi-arid, hot plateau before reaching the delta, which is slightly wetter. But while the upstream areas get rainfall from the south-west monsoon from June-September, the delta gets most of its rainfall from the north-east monsoon from October-December, via intense cyclonic storms.

The story begins 2000 years ago with the construction of the Grand Anicut by the Chola king at the mouth of the delta. It remains one of the oldest water regulation structures in the world, still in use (Agoramoorthy, 2015) and allowed the formation of the massive irrigation system in the delta in the first century A.D. and the rich civilization it supported.

In the centuries that followed, the forested headwater catchments of the Western Ghats remained relatively untouched; but the scrub forest of the semi-arid Deccan plateau was gradually cleared to make way for cultivation as settlers moved in. Rulers between the 10th and 17th centuries constructed a series of small earthen bunds on the tributaries to store runoff in small water bodies or "tanks" to create sources of water for paddy irrigation. These tanks would capture a small part of the runoff and the overflow would cascade to the next tank in the chain. This system provided irrigation to each village, while also allowing significant flow to downstream communities (Shah, 2003). By the time the British came to India, irrigation and paddy cultivation was well established in the delta and to a small extent in the command areas of tanks, controlled primarily by upper caste farmers. Everywhere else farmers depended on rainfed millets and other dryland crops for subsistence.

Tensions first emerged in the middle of the nineteenth century, when the princely state of Mysore Government began to expand irrigation by proposing to build a number of new dams. The then lower riparian, the British Madras Presidency, objected that the proposed storage structures would impact flows into the delta. An agreement was reached in 1892 and renegotiated in 1924. The agreement allowed construction of the Krishnarajasagar Reservoir (KRS) in Mysore but also capped any future extensions of irrigation in Mysore State from the Cauvery while simultaneously permitting the Madras Presidency to build the Mettur reservoir. The basic principle enshrined these agreements, was that no injury could be caused to the existing irrigation downstream. Essentially the agreements protected the age-old rights of the delta farmers and any tax revenue it generated for the colonial power (CWDT, 2008).

Post-independence, the constitution of newly independent India made water a state subject. Inter-state river sharing, however, remained under central government jurisdiction.

Both states embarked on rapid dam building. Between 1970 and 1980, Karnataka alone built four new large dams on tributaries of the Cauvery, without seeking prior consent from Tamil Nadu. This prompted a series of legal challenges from Tamil Nadu. Following two decades of heated negotiations, the Supreme Court finally appointed a Tribunal to adjudicate the matter in 1990. These triggered violent anti-Tamil riots in Karnataka, which killed at least 18 people.

The first task of the Tribunal was, of course, to establish how much water was there and how much was being used by each of the claimants. This was done based on measurements at the terminal outlet of the basin, namely lower Coleroon Anicut, as well as at KRS and Mettur reservoirs. Based on a baseline dataset of flow measurements from 1933-1971, the median yield in the basin was established to be 740 TMC with Karnataka contributing 54 percent, and Tamil Nadu 32 percent, with the remaining 14 percent by Kerala state.

The committee then established the amount of water that was in use by both states. According to this, Tamil Nadu was using 567 TMC, and Karnataka 177 TMC. In other words, the upstream states were supplying two thirds of the water in the river, but only contributing to a third of water use. Importantly, even in 1990, the combined utilisation of waters in the Cauvery river in all the basin states already exceeded the total annual yield (CWDT, 2008), so the amount available was far lower than the demand. The core of the dispute was on what principles should be used to share the scarce resource.

Karnataka's position:
First, Karnataka invoking the principal of absolute territorial sovereignty (Anand, 2004), claimed its rights over Cauvery waters flowing through its territory, without interference from any third party (CWDT, 2008). Essentially, Karnataka would be able to follow a policy of zero water flowing across the border, if it so chose.

Second, Karnataka argued there had been historical injustice, arguing that until the end of the 19th century, the princely States of Coorg and Mysore had only drawn on the waters of the Cauvery from the river bed and tanks only in small quantities. Agriculture was primarily rainfed and farmers in the state had suffered as a consequence. Moreover, efforts by the princely state of Mysore to utilise the waters of Cauvery were stymied by the British Government of Madras (Anand, 2004; Pani, 2009). While farmers in Cauvery Delta had able to irrigate multiple paddy crops making use of both south-west (June to September) and north-east (October-December) monsoons, in Karnataka, farmers were confined to one mostly rainfed crop during the south-west monsoon season (CWDT, 2008).

Third, a large portion of the water is wasted to the sea and not properly utilised, suggesting that Tamil Nadu could harvest more of its water, instead of depending entirely on releases from Mettur.

Tamil Nadu's position:
Tamil Nadu invoked the principle of absolute riverine integrity (Anand, 2004), claiming their rights to river's natural flow as well as historical or prescriptive right over water. The rights over natural flow of the river in effect would not allow any alterations upstream. Tamil Nadu's also requested the court to honour the earlier agreements that recognised the ancient rights of delta farmers (CWDT, 2008).

Second, Tamil Nadu argued that rice was the dominant crop in the delta and the staple food of the state. Tamil Nadu, acknowledging that while it might be theoretically possible to make more effective use of water by changing cropping patterns, rejected the possibility of any cropping pattern changes, considering the importance of the delta for the state's rice production (CWDT, 2008).

Third, Tamil Nadu argued that contrary to Karnataka's claims, although it did receive rains during the North-East monsoon, the low-pressure cyclonic storms that characterize the North east monsoon were erratic, with much of the rain occurring in the span of a few days. The intense showers in the delta region, could not be harvested and would inevitably drain away into the sea, they argued. In contrast, the South-West monsoon rains are more "dependable" and evenly spread throughout the season, but the delta does not benefit from them (CWDT, 2008). Tamil Nadu argued that the north-east monsoon should not be factored in allocation decisions.

Principles of Allocation

After 17 years of deliberation, the court declared the final award in 2007. In doing so, the court avoided both extreme positions and instead, invoked the Helsinki rules of 1966 of equitable apportionment. The court decreed that neither state could claim exclusive ownership of such waters so as to deprive other riparians of their equitable share (CWDT, 2008). Many hoped that the judgement would settle the dispute once and for all, but these hopes were unfounded. Among its many lacunae, the tribunal did not offer much guidance on what to do in drought years when the reservoirs failed to fill up. Not surprisingly, it is exactly in dry years, when the conflict has erupted. It has become politicized and framed in terms of state pride and linguistic identity (Pani, 2018). Indeed, every drought year since the 2007 judgement, has seen an outbreak of violence with serious economic consequences (BBC, 2016; New York Times, 2012). The Associated Chambers of Commerce and Industry of India (ASSOCHAM) estimated the economic damages from the 2016 riots alone, to be $3.5 billion (Economic Times, 2016).

The present: How the landscape changed in the last 50 years

To understand the evolving nature of the conflict, I will now summarise recent research on the Cauvery basin and delta to demonstrate why the landscape envisioned by the courts, that of a river with a "fixed yield", did not remotely resemble conditions on the ground.

Non-canal command areas: the upper Cauvery

Research in one semi-arid upper Cauvery catchment, the Arkavathy sub-basin, near Bangalore offers some insights. This sub-basin terminates in the TG Halli reservoir constructed by the British in 1937 as the primary drinking water source for Bangalore, then a small cantonment town. For many centuries, in the TG Halli sub-basin, irrigation was only possible in the command areas of these communally managed tanks and areas where the groundwater table was shallow (Srinivasan, Lele, et al., 2017).

But over time, the sub-basin saw many changes. In the last 4 years, inflows into TG Halli reservoir gradually declined by almost 80-90 percent. In fact, today the reservoir does not supply any water to Bangalore. Other water bodies in the catchment also exhibited a drying trend (Penny et al., 2017). On investigating all possible causes of this decline, we found that neither annual average rainfall nor daily rainfall intensities have changed significantly. The decline could also not be explained by the higher temperatures causing trees to take up more water. Rather, direct anthropogenic factors are to blame (Srinivasan et al., 2015).

The biophysical changes:

Groundwater over-exploitation has played a key role in the drying of streams. Till the 1960s, well drilling was severely constrained by the ability to drill into hard rock formations that underlie the region. A new borewell drilling technology called "down-the-hole" (DTH) drilling, that emerged in the late 1960s, decreased both drilling time and costs, allowing farmers to drill deeper in search of water. For the first time, farmers' choice of crops was no longer limited by the amount of rainfall.

With the advent of groundwater irrigation, the communally managed tank systems were not maintained, which also led to their demise. Groundwater became the great leveller. Previously, irrigation was only available to upper-caste elite landowners, in tank command areas, borewells allowed farmers everywhere access to irrigation. Indeed, early government schemes explicitly offered free or subsidized borewells to marginalized communities and introduced a low flat rate electricity tariff in the 1980s. This meant that the farmers did not have to worry about either the depth of the water table or the volume of groundwater they were pumping.

Empowered with electricity subsidies, borewell drilling grew rapidly in the 1980s and 1990s. Land use maps show that irrigation, which was previously confined to tank command areas, began to spread everywhere. Around the same time, another set of pertinent, but unrelated development interventions took place. In the early 1980s, under a World Bank aided "Social Forestry Programme," farmers began to plant eucalyptus trees in a big way. The area under eucalyptus plantations only 11 sq. km. in 1973, mostly in government-owned plantations, had expanded to almost 280 sq. km 2013, the vast majority of it on private lands. By 2016, eucalyptus and irrigated horticultural crops had taken over much of previously rainfed cropland. The problem is the replacement of rainfed millet fields with deep-rooted eucalyptus plantations has only exacerbated groundwater decline (Calder et al., 1993).

The early borewells drilled in the late 1970s report a shallow groundwater table, 5-7 meters below ground level (mBGL). By the mid-1990s, the shallow weathered aquifer had completely become de-watered, as evidenced by the disappearance of shallow wells as a source of irrigation in government records. Farmers began to drill deeper to tap the increasingly rare, water bearing fractures. Despite the declining water table and high rate of failure, borewell drilling has not slowed. In fact, paradoxically, the number of borewells continues to increase rapidly even today and borewells in rural areas of the upper Cauvery catchment range from 150-350 mBGL.

Alarm bells were raised over rapidly declining groundwater tables. The solution that emerged to address this was "watershed development." Building check dams – small masonry structures of 1-2 m in height and farm bunds – to arrest runoff and allow water to percolate into the ground. But by diverting runoff into groundwater, these merely accelerated the decline of water flowing into downstream tanks.

The socio-economic drivers:

The biophysical changes, described above, had underlying socio-economic drivers. Our research suggests that farmers follow a "go big or quit" strategy. Only older, small holders still grow rainfed crops for subsistence. With employment options growing in nearby urban areas, it simply did not make economic sense to remain a rainfed farmer. Regression modelling on farmer surveys shows that farmers, who have functioning borewells grow horticultural and vegetable crops for lucrative urban markets. Farmers whose borewells have failed, prefer to place their land under eucalyptus plantations, both because of labour and water scarcity. Eucalyptus plantations are harvested once every 3-4 years by contractors. While they do not bring in more income per acre than rainfed crops, they allow farmers to separate the return from land and labour and pursue non-farm or even white collar urban jobs (Patil et al., 2017).

It is also important to note, that these impacts have not been equitably distributed. Borewell ownership coincides with land size and only a small fraction of farmers has access to irrigation. In 1970, water for irrigation was only available to a privileged few who had access to water from the tanks. Groundwater irrigation, and the free electricity policy, were supposed to change this. Yet, because of over exploitation, only the richest farmers are able to chase the water table. As a result, access to irrigation is once again skewed (Thomas et al., 2015), revealing the 'social justice' aspect of India's shift to groundwater. In effect, the richest farmers are able to access subsidised irrigation technology, and capture the resource.

Canal command areas: The Cauvery Delta

In canal command areas like the Cauvery delta, a slightly different story emerges. Here, flood irrigated paddy remains the dominant crop. The nature of the irrigation infrastructure is such, that it does not allow individual farmers to much deviate from this.

The Mettur reservoir is the centrally regulated source of irrigation water. Every year, farmers wait for an official announcement about when and for how long water will be available. The nature of the irrigation infrastructure, which has not changed much in the last 2000 years, with field to field irrigation and rotational delivery of water, does not allow farmers much control on the quantum and timing of irrigation. Additionally, the irrigation and drainage systems are dilapidated and unable to effectively deliver irrigation (ADB, 2018).

The decline in canal water has also led to inequitable distribution of irrigation water. While upstream farmers benefit, some tail-end areas no longer have access to irrigation water and suffer from seawater ingress along channels. There is anecdotal evidence of salinization and a gradual shift to aquaculture along the cost. Inland, surprisingly, despite evidence of less water being delivered to the canals in the delta, irrigation does not seem to have declined. Instead, farmers increasingly switched to groundwater for irrigation. There is also evidence that farmers are changing crop varieties to cope, growing one long-duration paddy crop instead of two short-duration paddy crops (EPW Editorial, 2002).

Finally, there is evidence of increasing mechanization. Even in villages where cultivated area has stayed the same, the number of cultivators and agricultural laborers has declined (Census of India, 1991, 2001, 2011). The attribution of this shift to push and pull factors remain debated. On one hand, Tamil Nadu is one of the most urbanized states in the country, so migration to urban areas is occurring is likely resulting in agricultural labour scarcity. Further, there are claims that employment guarantee schemes are also redirecting rural farm labour away from agriculture. On the other, farmers are coping by depending on machinery reducing demand for labour.

To summarise these complex socio-environmental changes

There has been an "upstream migration of water assets" (Sivapalan et al., 2014), upstream areas are abstracting more, leading to the drying of the delta and conflict. But less water flowing downstream, agriculture in the delta has continued to intensify mainly due to groundwater abstraction.

The biophysical processes are not always the visible, obvious ones. In addition to dams, groundwater over abstraction, watershed development and fast-growing plantations are all contributing to drying downstream, but these are often poorly understood outside the scientific community. Climate change will exacerbate this with more extreme rainfall events.

Likewise, the motivations of farmers in drilling borewells, growing horticultural crops, or constructing farm ponds are similarly overlooked by scientists. Each individual farmer in trying to increase income, seeks to increase access to water in a landscape where water is *the* limiting factor on farm productivity, but in doing so may deprive another downstream.

To identify sustainable and equitable transitions to sustainability, we have to start at the root of the problem. A drying delta is NOT a problem because there is insufficient water for drinking and hygiene, these are only a small fraction of water use. It is also not because food production needs to be sustained. We no longer live in a world where people living in the Cauvery basin consume rice grown locally and as a country, India is a net exporter of rice. In theory, if people have decent incomes, food can be procured from food grown in more water abundant regions (Srinivasan et al., 2017). Rather, I will argue that water scarcity is a livelihood problem. Ultimately, the challenge that confronts us is how to ensure everyone who lives in the region, can earn a decent living on shrinking parcels of land with the limited water that exists in the basin. This might mean somehow making farming more profitable or creating non-farm jobs in water-scarce regions, all while ensuing the process of allocation is fair.

The future: How can we better anticipate change?

To return to my original question: if we had a time machine to go back to 1970, could we possibly have imagined the changes the landscape would undergo? The research points to a complex, rapidly evolving system, with complex and poorly understood causal linkages. Even the Supreme Court appointed tribunal, in all its wisdom, with numerous experts on call, could not foresee the implications of groundwater exploitation, expansion of plantations, mechanization of agriculture and wastewater recycling in the Cauvery basin. So how could we do better?

Water engineers have approached this problem of prediction using scenario analyses, comparing snapshots of the world at some future date. They describe the biophysical system in computer simulation models, and then test the outcomes of different infrastructure choices. But this assumes perfect foresight. For a scenario to eventualise, it must be internally consistent. The modeler must already know how each actor will respond to an infrastructure choice, so that scenarios themselves represent plausible end states.

Myriad examples of unintended consequences of infrastructure investments, suggests that in fact engineers in fact do poorly at recognizing how actors will respond to infrastructure choices (Sivapalan et al., 2014; Srinivasan et al., 2017). The alternative is to build "better" models that study transition pathways that account for path-dependence, adaptive responses of human actors, lock-ins and tipping points and form the basis of adaptive policy.

This may appear to be a Herculean task, but we do have a rich body of existing knowledge to draw on. The challenge is that the knowledge is distributed among different people, who work in disciplinary silos, with little exchange of information. And while no single group could possibly have got it right alone, each sees a piece of the whole, not unlike the proverbial elephant and the six blind men. But if they worked together perhaps they could reveal the elephant in the room. But this will require new ways of collaborating and importantly, communicating research in ways that it can be understood by others.

The future: How can we better influence change?

Anticipating change is only valuable if we can do something about it. Researchers are not mute spectators. We can and should be active participants in the process of ensuring that humankind is on a sustainable and equitable pathway.

So where do the opportunities to influence the future of the Cauvery delta lie? We can either harvest more water, use water more efficiently or create livelihoods that need less water. In any case, to be sustainable we have to be able to ensure that we don't abstract more water than we have.

Harvesting rainwater in the delta: We have to ensure that more of the floodwater in the delta can be harvested for use. Many of the traditional rainwater harvesting structures as well as the embankments have fallen to misuse and need to be restored.

Water use efficiency: We could boost water productivity and water use efficiency by decreasing "non-beneficial" evaporative losses through new technologies or crop varieties that are drought resistant. However, these will have to be done in a way that ensures that water is actually being saved.

Doubling incomes with less water: We could boost farmer incomes with less water, considering both on-farm and off-farm income opportunities and focusing on the poorest farmers. This may involve crop support prices or market creation for rainfed millets, re-aligning employment guarantee schemes, and better crop insurance. It may also involve innovating new crop varieties, creating cold storage facilities, promoting integrated farming, boosting ecotourism through farm stays or innovating supply chains so farmers capture more of the market value.

Water Accounting: Once water resources in a river basin are fully allocated, supply solutions cannot address the problem. The hard reality is that water is a "zero sum" game. There has to be a mechanism that ensures that total annual water consumption by various sectors is within the limits of annual water availability for each river basin with allowances for environmental flows. The challenge is the lack of comprehensive data on both consumption and availability. This means we have to invest in improving water accounting (Karimi et al., 2012)

Research activities as part of the Prince Claus Chair

The Prince Claus Chairship brings together work at two Research Hubs, the Water, Climate and Sustainability hub and the Future Food hub, in addition to IDS, here at Utrecht. Additionally, I hope to work collaboratively with TU Delft and IHE, Delft as part of larger collaborative work between India and the Netherlands.

My work as part of the chair will focus on the following research areas:

Understanding, anticipating and influencing change in Cauvery Delta
Work undertaken in collaboration with the post-doc associated with the Prince Claus Chair, Dr Crelis Rammelt, will seek to understand the patterns and drivers of change in the Cauvery delta over the last 30 years. To do this, we are synthesizing biophysical and socio-economic datasets such as land use/land cover, irrigation availability and source, salinity, crop varieties, agricultural labour participation and urbanization.

We hope to typify different transition pathways that villages in the delta have taken. We want to know, why some villages are abandoning agriculture, while others are intensifying, where mechanization is occurring and where aquaculture is emerging.

We also recognize that the Cauvery delta clearly cannot be studied in isolation. Our ability to anticipate change in the delta relies on a better understanding of the larger river basin context. With the help of a PhD student at my home institution, ATREE, Bangalore, collaborators at CEH, UK and IHE Delft, we hope to contribute to this key scientific challenge of understanding the underlying the biophysical and social drivers of change and conflict in the Cauvery basin.

Establishing biophysical limits and tipping points
To ensure sustainable transitions, we will need to be able to anticipate irreversible tipping-points in terms of, for instance, land subsidence and soil salinization before they manifest. There is anecdotal evidence that land subsidence and soil salinization

are an emerging concern in the Cauvery delta, but quantitative evidence is lacking. We hope to make use of techniques applied in the Mekong Delta by Utrecht University researchers, to establish the rate and potentially causes of land subsidence apply novel Earth Observation techniques to better quantify how much sediment is being trapped in reservoirs.

Comparative study of deltas

The biophysical commonalities that deltas everywhere in the world, means that they tend to face similar challenges. Deltas tend to be heavily populated and intensively cultivated. Relative sea level due to rising sea levels and land subsidence, flooding, salinization and sea water ingress are common problems. Yet, there are also differences, in the socio-economic, governance and cultural systems. With help from a student at Utrecht, we hope to evolve useful classification typologies that will help us characterize deltas. This will help us identify clusters of deltas, to understand which lessons can be transferred across sites.

Innovation activities

We need more interdisciplinary knowledge generation on complex socio-environmental systems, but we also need translation and communication of the knowledge to spur innovation of solutions. If we hope to influence the transition to sustainable and equitable future, knowledge cannot stay locked in journal publications and we need new institutional mechanisms and partnerships for this.

As Director of a new Centre in Social and Environmental Innovation, I hope to move being an observer of change to being an influencer of change, focusing on translating knowledge through partnerships for capacity building, network creation and market transformation.

Sustainable Rural Livelihoods

A take away message from my talk today is that deltas in particular and ecosystems generally, cannot be sustained if the populations dependent on them cannot earn a decent living. One of the foci of the new centre will be then to take an ecosystem approach to rural livelihoods, by focusing on income increase that will also result in improvements in ecosystem services provisioning.

Sustainable and inclusive cities
India is rapidly urbanising, and the trend is likely to continue. But cities themselves will need to be redesigned to be sustainable, equitable living spaces. Because so much new infrastructure is going to get built in the coming decades, leapfrogging to a low-carbon, sustainable, circular economy offers a huge opportunity. Nature based solutions, in particular, offer promise in creating sustainable and inclusive cities.

Creating learning communities
Notwithstanding everything I have said about "anticipating and influencing change", in coevolving human-water systems, it is in fact impossible to have perfect foresight. At best, we can progress from an opaque crystal ball to a slightly clearer one. There will always be some "unknown unknowns". To account for these, the only way forward is adaptive management: constant learning and course correction.

One of the weakest links in achieving this, is that the absence of a culture of "learning by doing". Governments, philanthropists and corporates alike, who invest in the social sector are simply not incentivized to admit to failure. Once infrastructure is built or a policy is put in place, there is no looking back. Each year, monitoring and evaluation budgets remain unspent and simply lapse. Unintended consequences are not acknowledged till they become too big to ignore. The fear of "losing face" publicly means the same mistakes are repeated over and over again.

Yet, innovation and learning from past mistakes is a necessary pre-condition to achieving an equitable and sustainable future. Interdisciplinary approaches that are capable of assessing biophysical and socio-economic impacts are much needed. Along with scholars here at Utrecht's LandAc programme and IHE Delft, I hope to establish such "learning communities" in India, partnerships where scholars, governments, corporates, philanthropists can come together with farmers and water users. The hope is that if failures are presented as opportunities for everyone in the ecosystem to learn, a culture of monitoring, assessment and reflection will become possible.

The research and implementation agenda I have laid out, feels rather ambitious and perhaps not everything can be accomplished in the two years I will hold the Chair position. But with the networks I have formed, I hope we can find the funding and partners to break new ground in finding sustainable pathways for both the Cauvery and other Asian deltas as well as the broader water sector.

Acknowledgements

Before I conclude acknowledgements are due to the many who have helped me along the way.

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"To manage deltas, we must be able to look into the future and anticipate change."
Professor Veena Srinivasan

The Prince Claus Chair in Development and Equity was established by Utrecht University and the International Institute of Social Studies of Erasmus University Rotterdam, and rotates annually between the two institutions. Veena Srinivasan has been appointed as the holder of the Prince Claus Chair 2018-2020 and will work in close collaboration with the research hubs Future Food and Water, Climate and Future Deltas, together with International Development Studies at Utrecht University.

Veena Srinivasan has been appointed to the Prince Claus Chair at Utrecht University for her research into sustainable and inclusive food production in Asian delta regions. She is keen not only to contribute to delta and food research being conducted in Utrecht, but also to play a role in intensifying collaborations between Dutch and Indian institutions. She will engage in comparative research across delta regions within India (Ganges and Cauvery) and across Asia (Mekong and Indonesia).
On the one hand, she is researching how to better anticipate water and food futures in the light of changing climate conditions, migration, and urbanisation. On the other, she is keen to apply the research findings in order to improve land and water management, so that the transition is both sustainable and inclusive. As Director of a newly established Centre for Social and Environmental Innovation at ATREE, Srinivasan aims to improve science communication and participatory decision-making. She will also foster partnerships with industry and communities to find innovative solutions and maximise the impact of scientific research.