CLIMATE CHANGE, MIGRATION AND ADAPTATION IN DELTAS

Key findings from the DECCMA project

DECCMA

CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

UNIVERSITY OF GHANA

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

JADAVPUR UNIVERSITY INDIA

UNIVERSITY OF Southampton

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OUR APPROACH AND RESEARCH ACTIVITIES

WHY ARE DELTAS IMPORTANT?

Deltas are home to 500 million people worldwide and known as a climate change “hotspot” – a place where high exposure to climate stresses coincides with high levels of vulnerability.

DECCMA has been undertaking research on climate and environmental change, migration and adaptation in three delta systems: the transboundary Ganges-Brahmaputra-Meghna megadelta (comprising the Indian Bengal delta, as well as the bulk in Bangladesh), the Mahanadi delta in India, and the Volta in Ghana.

1. Volta delta in Ghana

2. Mahanadi delta in India

3. Ganges-Brahmaputra-Meghna megadelta, compising the Indian Bengal delta (outlined in purple) and the bulk in Bangladesh (outlined in red)

WHAT WE HAVE DONE

In each delta we have done the following activities:

- Risk mapping based on the IPCC framework (hazard, sensitivity, vulnerability, adaptive capacity)
- Analysed how environmental shocks and change affects economic output, employment and linkages, using macro-economic models and scenarios
- Investigated adaptation strategies and migration behaviour across the deltas through surveys of women and men in more than 5000 households in areas from low to high exposure to natural hazards
- Investigated the multiple dimensions of well-being and the lived experience of migrants in cities of the deltas through surveys of more than 2500 migrants in seven destination cities and towns.
- Compiled inventories of documented adaptation
- Reviews of governance and policy

This common approach allows us to compare across deltas.

Conducting interviews in Ramgoti, Bangladesh

(Photo: DECCMA Bangladesh)

Conducting interviews in Indian Bengal delta

(Photo: Victoria Price)

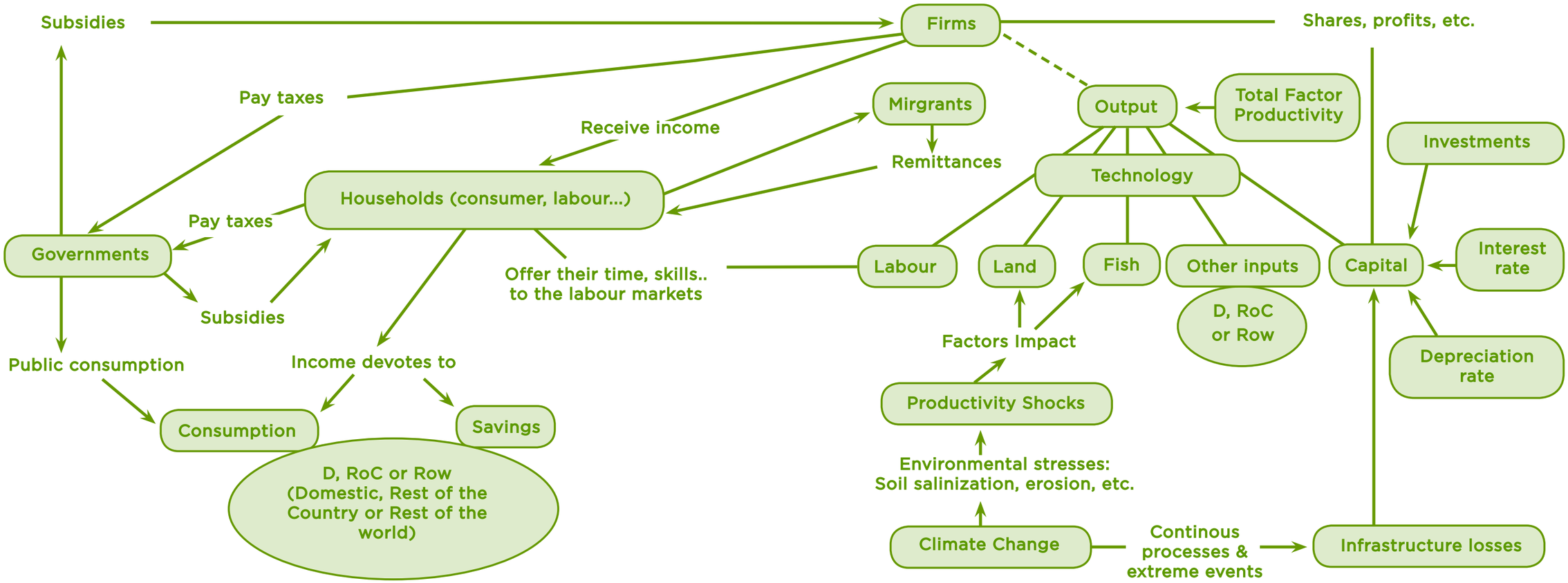
Conducting participatory exercises in the Mahanadi delta

(Photo: Giorgia Prati)

WHAT WE HAVE DONE: ECONOMIC MODELLING

- Developed a Computable General Equilibrium (CGE) model (Delta-CGE) based on custom Social Accounting Matrix and Input-Output tables to investigate delta economies under different climate scenarios and adaptation policy directions.

Structure of the Delta-CGE model to determine economic impacts of climate change



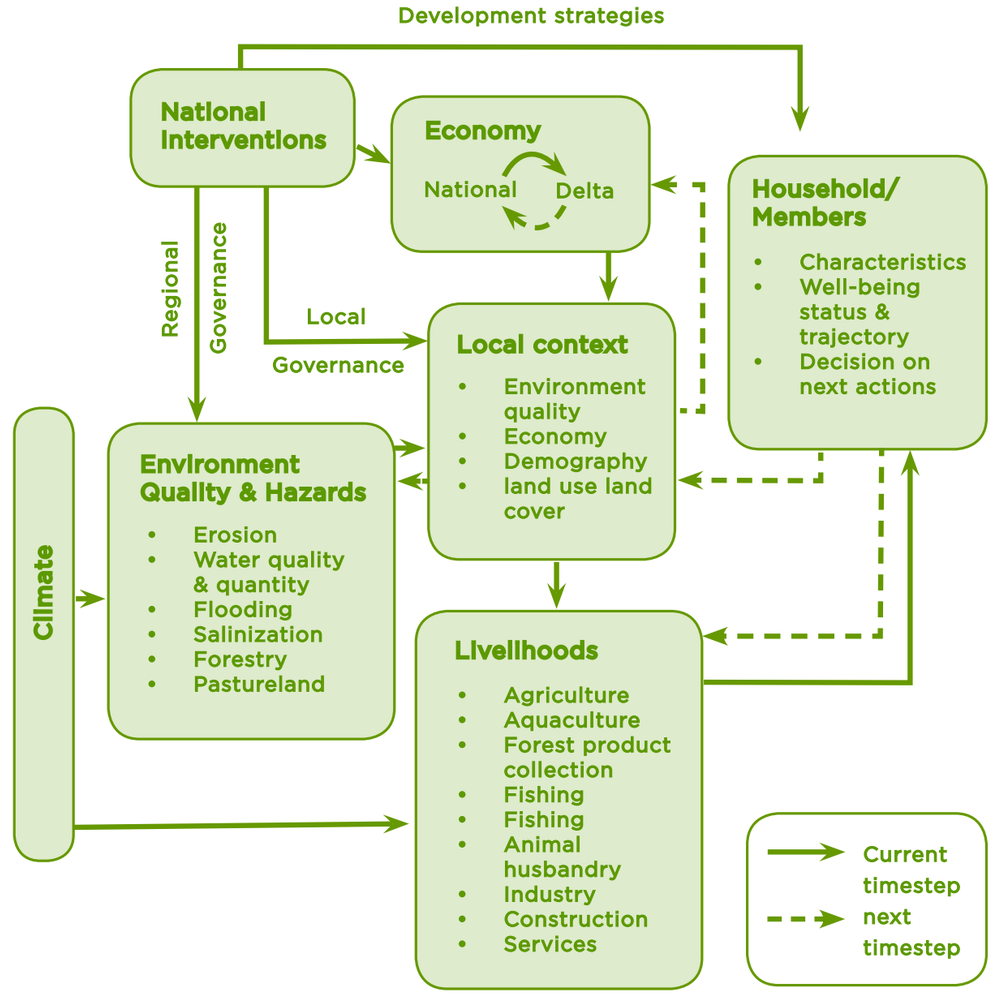
More information:
Arto, I., García-Muros, X. Cazcarro, I., González-Eguino, M., Markandya, A., Hazra, S. 2019. The socioeconomic future of deltas in a changing environment. Science of the Total Environment 648, 1284-1296.

WHAT WE HAVE DONE: INTEGRATED ASSESSMENT MODELLING

- Developed a conceptual model to investigate plausible future household migration and adaptation patterns

- Combined bio-physical and socio-economic models in a quantitative framework to investigate the causal relationships resulting in migration and/or adaptation. The integrated model links across scales, from the high level (national and regional interventions and economy) down to the household level and individual decisions. It uses the (empirical and simulated) knowledge generated within DECCMA. Our hybrid model framework is designed to be computationally efficient utilising both process-based and statistical methods. The outputs of the integrative model are designed to inform the consequences of different adaptation policy directions on household behaviour.

Structure of DECCMA's integrated assessment model



More information:
Lazar, A.N., Nicholls, R.J., Payo, A., Adams, H., Mortreux, C., Suckall, N., Vincent, K., Hazra, S., Amisigo, B.S., Rahman, M., Haque, A., Adger, W.N., Hill, C.2015. A method to assess migration and adaptation in deltas: A preliminary fast track assessment, DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available online at: www.deccma.com

PRESENT SITUATION IN DELTAS

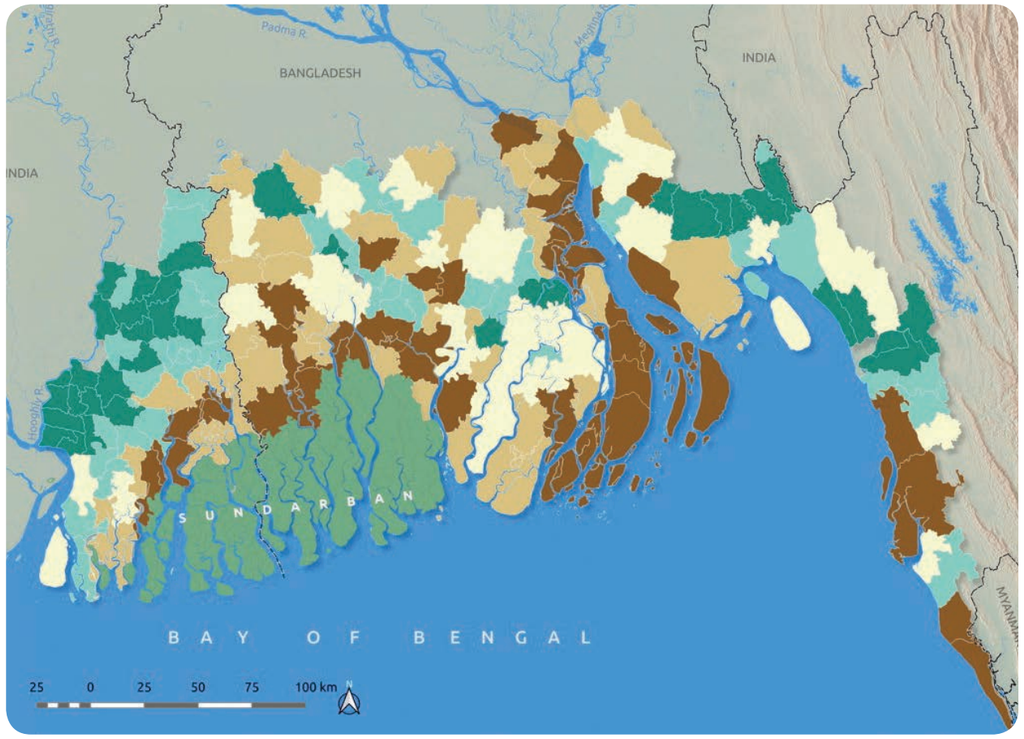
Adapting to rising water levels is often essential for delta residents (Photo: Saiful Alam)

AT RISK FROM CLIMATE CHANGE – SEA LEVEL RISE, COASTAL EROSION, FLOODING, SALINIZATION

DECCMA has conducted the first transboundary assessment of levels of social vulnerability to climate change in the Ganges-Brahmaputra Meghna delta in Bangladesh and India. The delta has a population of nearly 57 million and is exposed to a range of hazards including sea level rise, coastal erosion, flooding and salinization, often exacerbated by climate change and other stresses. An assessment of social vulnerability helps to identify which communities are more vulnerable to these environmental changes, and can serve as guide to inform adaptation actions.

The sub-district level assessment (Upazila level in Bangladesh and Community Development Block in India) is based on Principal Component Analysis of census data from each country. It shows that a social vulnerability gradient exists across the coast, with the most vulnerable communities on the delta margin. Looking at change over time from 2001-11 shows that efforts to address poverty, generate non-farm employment or improve health and sanitation status have played a role in reducing social vulnerability. However, major cyclones such as Sidr (2007) and Aila (2009) and other climatic hazards have increased social vulnerability in some sub-districts.

Assessment of levels of sub-district level social vulnerability in the transboundary Ganges-Brahmaputra-Meghna delta in Bangladesh and India



LEGEND

- -------- International Boundary
- Mangrove forest

Social Vulnerability Index (2011)

- Very High
- High
- Medium
- Low
- Very Low

More information:
Das et al., 2018. Assessment of spatio-temporal dynamics of social vulnerability in Ganges-Brahmaputra-Meghna delta, Draft, in preparation

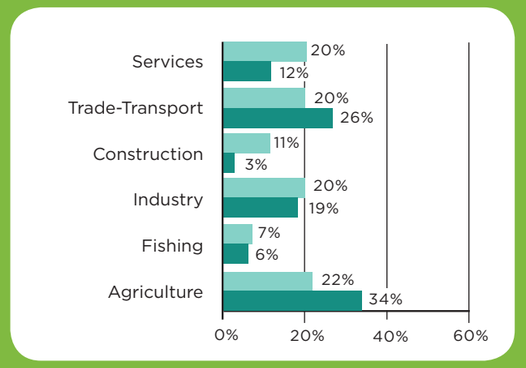
DELTAS PLAY A KEY ROLE IN NATIONAL ECONOMIES

Deltas are significant contributors to the national economies of Bangladesh, India and Ghana. They supply, and sometimes add value to, natural resources such as agriculture and fishing, which comprise 16-29% of the GDP in the deltas. Input-Output Analysis shows that other activities such as services, trade and transportation account for 50% of the income in Asia and 40% in the Volta. In terms of employment, however, the role of the primary sector in the economy is more relevant than in terms of GDP. The share of the employment engaged in the primary sector ranges from 32% in the Indian Bengal delta to 58% in Mahanadi. This difference between the sectoral distribution in GDP and that of employment is the consequence of the low productivity of the agricultural sector, in which subsistence production dominates, compared to other economic activities.

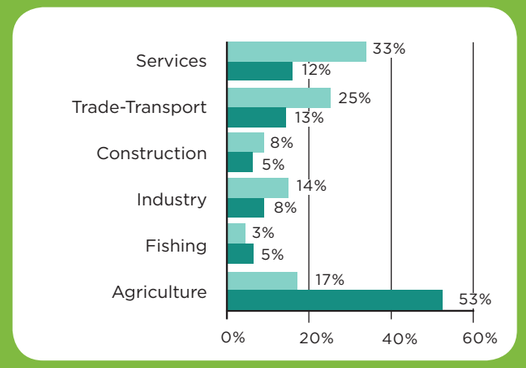
Looking at the breakdown of contribution to GDP and employment also enables analysis of the potential sectoral impacts of changing deltas – for example what would happen if there is a disappearance of agriculture. The integration of agriculture with other sectors means that the indirect effects of loss of agriculture would be higher in the Volta (8.3%) and GBM (over 5%) compared with the Indian deltas. These indirect losses are linked to the importance of the food processing industry, and in the GBM also due to textiles and leather transformation.

Distribution of GDP and employment by sector and delta, 2011

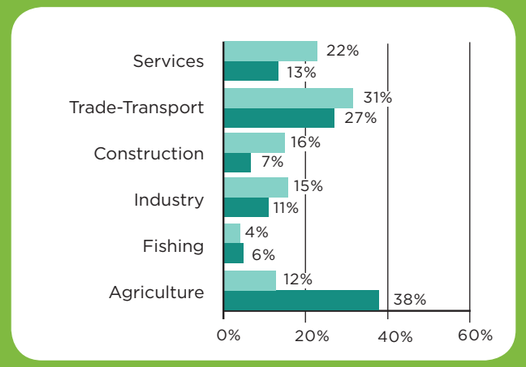
Volta GDP and employment



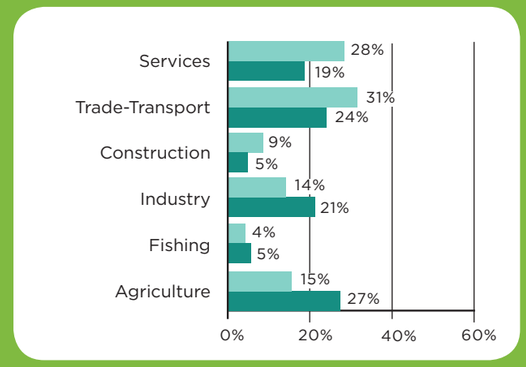
Mahanadi GDP and employment



Ganges-Brahmaputra-Meghna GDP and employment



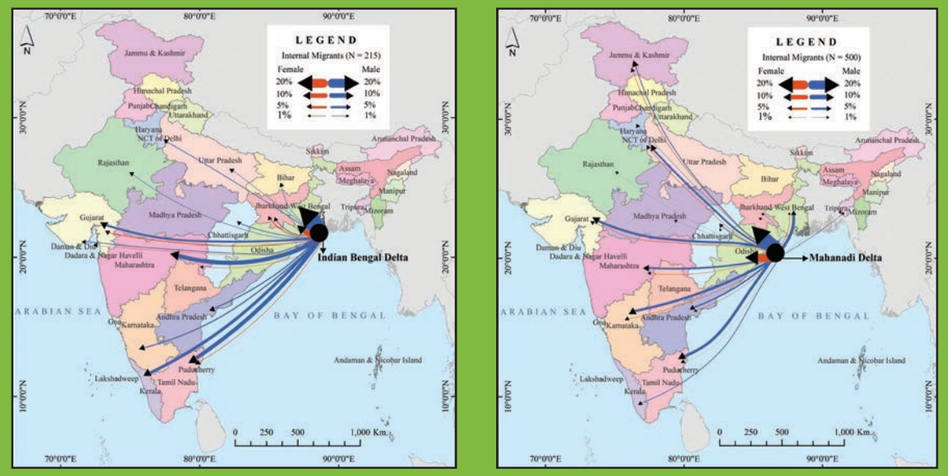
Indian Bengal delta GDP and employment



More information:
Cazcarro, I., Arto, I., Hazra, S., Bhattacharya, R.N., Adjei, P.O-W., Ofori-Danson, P.K., Asenso, J.K., Amponsah, S.K., Khondker, B., Reihan, S., Hosser, Z. 2018. Biophysical and socioeconomic state and links of deltaic areas vulnerable to climate change: Volta (Ghana), Mahanadi (India) and Ganges-Brahmaputra-Meghna (India and Bangladesh). Sustainability 10(3), 893.

MIGRATION FROM RURAL AREAS TO NEARBY URBAN AREAS IS A CONTINUING TREND, DRIVEN LARGELY BY ECONOMIC OPPORTUNITY

People have always been mobile within deltas. The natural environment in deltas is very dynamic and mobility is one way to manage this. Rural-urban internal migration predominates, and economic reasons are cited by migrants as the primary reason for their migration – for example the opportunity for employment. Migration patterns are also strongly gendered. The majority of migrants are men, and in all three countries over three quarters of migrants move within their own countries. Women tend to move for family reasons (for example to join a spouse, or to get married). Evidence from the Indian Bengal delta shows that gender differences in migration patterns reflect the gendered nature of the labour market. Men tend to move to the peri-urban areas, where they find opportunities in the construction industry; whereas women tend to move to the centre of the city to work as domestic helpers.

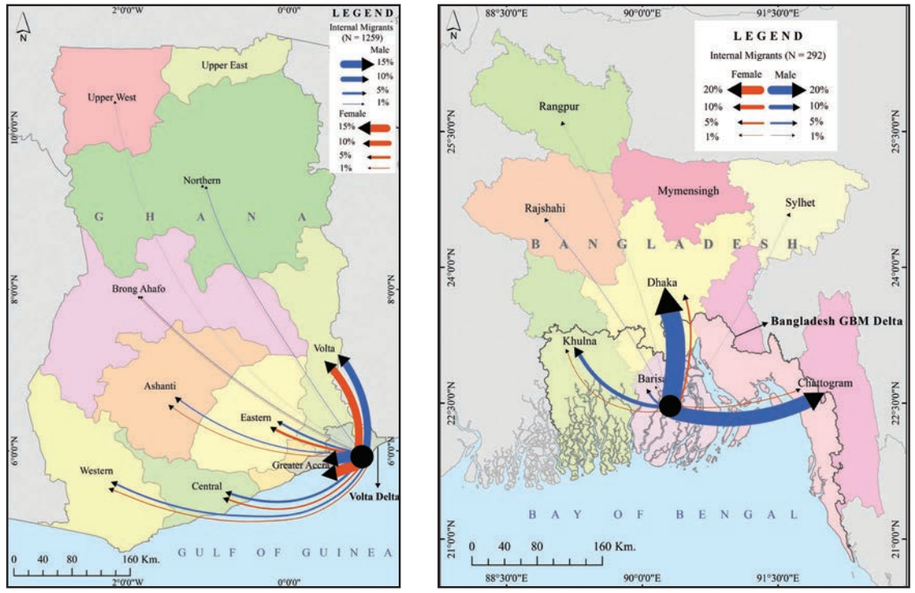


Destinations of internal male and female migrants from the Indian Bengal (left) and Mahanadi (right) deltas

Flooding is a regular occurrence in deltas (Photo: Saiful Alam)

MIGRATION HAS CONSEQUENCES IN BOTH SENDING AND RECEIVING AREAS

The implications of migration depend on the circumstances under which it has taken place. In particular, implications depend on whether migration is voluntary or involuntary – the latter being when people do not really wish to move but do so due to an absence of options in their home location. Involuntary migration can contribute to urban centres becoming crucibles of risk, with poverty in terms of material status and perceived well-being (even if the ability to remit money back home improves material well-being in migrant-sending areas). Voluntary migration is more likely to be deemed successful by migrants and families left behind.

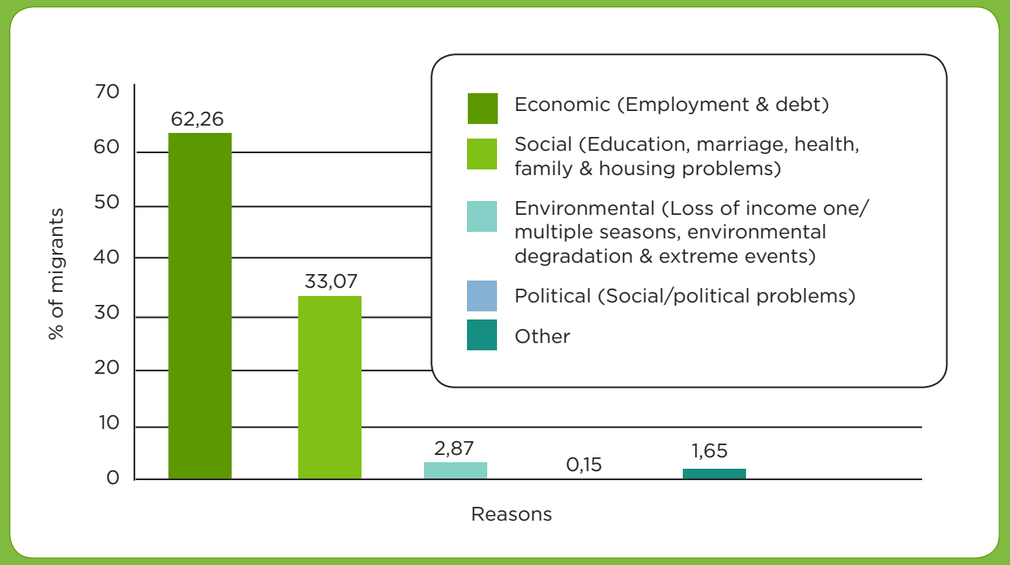


Destination of internal male and female migrants from the Volta (left) and Ganges-Brahmaputra-Meghna (right) deltas

ENVIRONMENT IS A PROXIMATE CAUSE OF MIGRATION

Only a small proportion of respondents (less than 3%) singled out an environmental cause as the main reason for their migration. However, one third of all households with migrants perceived that there was an increased exposure to environmental hazards, and between 40-80% of the respondents across the four deltas associated environmental factors with more insecure livelihoods. So rather than having a direct effect, climate and environment affect migration because they affect people's ability to earn a living, particularly for slow-onset environmental hazards such as drought and coastal erosion. In the Volta delta, for example, there is a strong positive association between perceived impact of droughts on economic security of livelihood and migration.

In our deltas we also find evidence of whole households that have been displaced as a result of environmental change, for example erosion and flooding.



Main reason for migration across all four deltas as reported by household heads (N=1803)

DISPLACEMENT AND PLANNED RELOCATION

Displacement and resettlement in the Mahanadi delta

After watching land and houses in Satavaya Gram Panchayat fall into the sea, the state government of Odisha has taken a pioneering and "humanitarian approach" to relocation. Since the 1970s eleven villages within the Rajnagar block have been eroded and at present a further five exist with an imminent fear of being swept into the sea or buried under the sand.

A "humanitarian approach" to resettlement

No in-situ adaptation measures were feasible in Satavaya, leaving resettlement as the only option to save the lives of the people residing in these villages. The communities from the five villages of Satavaya, Kanhupur, Barahipur, Magarakanda and Rabindrapalli under the Satavaya Gram Panchayat are being relocated 9 kilometres inland in the village of Bagapatia under the Gupti Gram Panchayat.

Land, houses and amenities provided

Resettled citizens are entitled to receive funds for constructing concrete houses with proper sanitation facilities. Electricity, drinking water, drainage, and connectivity have been improved. Community facilities have also been provided, including schools, a rural mother and child care centre, cyclone shelter, crematorium and temple. There is also a market place for trading, and a bus stop to ensure connectivity with other places.

The rapidly eroding coastline of Satavaya, Odisha causes houses and land to be washed into the sea

In addition to erosion, steadily encroaching sands can also make houses uninhabitable

Traditional "kutcha" houses made of mud and thatch are easily eroded and damaged by floods

Challenges of the resettlement process

The resettlement process has led to challenges for the government and the citizens. For the government, the major hurdle was getting a suitable plot of land for relocating 571 families. At the initial stages, negotiating with some elderly citizens was difficult to convince them to move. Some residents of the eroded settlements are migrant workers in Kerala and coordinating with them has been complex. For the communities relocated to Bagapatia, only homestead land has been provided and allotment of agricultural land is still under consideration at the government level. Most of the resettled citizens previously relied on agriculture as their primary livelihood option and without any cultivable land at Bagapatia, they have lost their ability to make a living. The distance from the coast also means that they are no longer able to fish.

Lessons learned for future resettlement

The experience of resettlement from Satavaya to Bagapatia highlights three lessons for the future. The first is the need for provision in resettlement and rehabilitation legislation and policies for people displaced by environmental factors. The second is that livelihood provision and support should take place concurrently with provision of homestead land and housing. The third is that a single nodal agency - or task team - from the beginning may facilitate coordination and expedite an effective and efficient process.

For more information:
Unpacking Resettlement – A journey from Satavaya to Bagapatia
https://www.youtube.com/watch?v=2ueRa1jVs-w

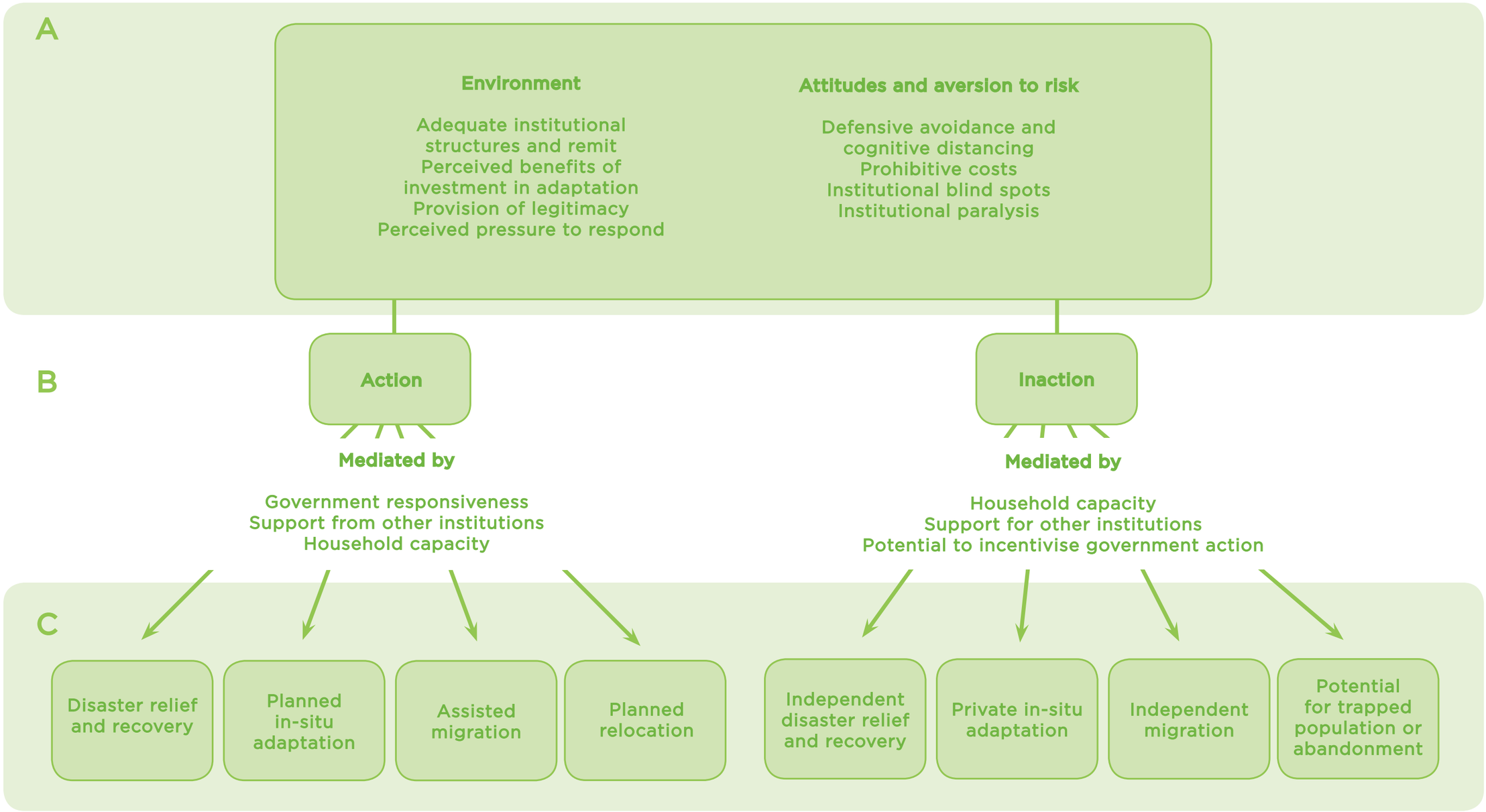
Houses under construction in Bagapatia.

Local women in Satavaya catch fish from the nearby sea for their daily subsistence, which will no longer be possible once they move to Bagapatia

Overhead tank for drinking water, cyclone shelter, and electrical lines at Bagapatia

How do governments decide when relocation should occur?

This conceptual model highlights how different factors interact to create uneven government responses to communities threatened by environmental change. Upper panel A: determinants of decisions; Middle panel B: decisions; Lower panel C: Outcomes for communities.



More information:
Mortreux, C., Safra de Campos, R., Adger, W.N., Ghosh, T., Das, S., Adams, H., Hazra, S. 2018. Political economy of planned relocation: A model of action and inaction in government responses. Global Environmental Change 50, 123-132.

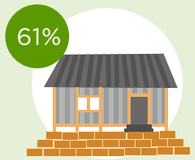
ADAPTATION IS OCCURRING NOW

There are both structural and livelihood adaptations in operation in the deltas.

In Bangladesh, the three most frequent household adaptations made in the last five years are:

The use of loans

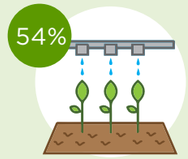
Planting trees around the home



Modifying the house

In the Indian Bengal delta, the top three are:

Changing the amount of fertiliser used on the farm



Making changes to irrigation practices

The use of loans

In the Mahanadi the top three are:

Changing the amount of fertiliser used on the farm

The use of loans

Planting trees around the home

In the Volta delta the top three are:

Buying or selling farming tools

Changing the amount of fertiliser used on the farm

Diversifying crops

LIVELIHOOD ADAPTATIONS

The particular mix of adaptations employed in each delta varies.

Agricultural adaptation: Use of fertiliser in the Indian Bengal delta (Photo: Sumana Banerjee)

Agricultural adaptation: Salt-tolerant rice varieties

More information:
Hossain, M.A.R., Ahmed, M., Ojea, E., Fernandes, J.A. 2018. Impacts and responses to environmental change in coastal livelihoods of south-west Bangladesh. Science of the Total Environment 637-638, 954-970.
Islam, M.A., Akber, M.A., Ahmed, M., Rahman, M.M., Rahman, M.R. 2018. Climate change adaptations of shrimp farmers: a case study from southwest coastal Bangladesh, Climate and Development.
Saha, D., Hossain, M.S.S., Mondal, M.S., Rahman, R. 2016. Agricultural adaptation practices in coastal Bangladesh: Response to climate change impacts, Journal of Modern Science and Technology 4(1), 63-74.

Agricultural adaptation: Use of irrigation for shallot farming in the Volta delta

(Photo: Katharine Vincent)

Integrated farming: Fish cultivation in the water channels and vegetable cultivation on the dykes

(Photo: Tuhin Ghosh)

Diversifying livelihoods away from crops and fishing in the Indian Bengal delta

(Photo: Farha Naaz)

STRUCTURAL ADAPTATIONS

Structural adaptations are often essential to stabilise mobile land and protect infrastructure and livelihoods. Structural adaptations in evidence in Bangladesh, India and Ghana include embankments, sea walls and flood gates. Houses are often modified to withstand flood risk – for example being raised or situated on concrete plinths. Cyclone shelters are present in the Asian deltas to reduce disaster risk.

Volta sluice gate
(Photo: Katharine Vincent)

Cyclone shelter in the Mahanadi
(Photo: DECCMA India)

Breakwater, Volta, Keta, Ghana
(Photo: Katharine Vincent)

Embankment construction in the Indian Bengal delta
(Photo: Shouvik Das)

MIGRATION AS AN ADAPTATION

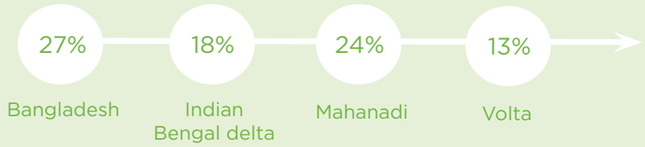
Migrants are often forced to live in precarious conditions in cities.

More information:

Ghosh, A.K., Banerjee, S., Naaz, F. 2018. Adapting to climate change-induced migration. Women in the Indian Bengal delta. Economic and Political Weekly 53(17)

Maharjan, A., Safra de Campos, R., Das, S., Srinivas, A., Singh, C., Bhuiyan, R.A., Ishaq, S., Shrestha, K., Dilshad, T., Umar, M.A., Bhadwal, S., Ghosh, T., Suckall, N., Vincent, K. 2018. Migration and adaptation in the context of environmental change: lessons from interdisciplinary work in South Asia. Submitted for publication.

Migration was used as an adaptation response in all three deltas:



Interestingly, though, migration was not among the top three strategies deemed to be successful adaptations in any of the deltas.

Many migrants move to urban and peri-urban areas

SUB-OPTIMAL POLICY AND IMPLEMENTATION FRAMEWORK FOR MIGRATION AND ADAPTATION

Governments seem averse to recognising migration and many countries have a “policy gap”. In India there is an almost complete absence of policy addressing migration. The lack of customary legal frameworks may discourage people from moving because they fear the loss of their land (e.g. in the Indian Bengal delta).

Examination of around 30 policy documents and laws took place in each delta to assess the state of both policy and legal frameworks (including customary frameworks) relevant to migration and to climate change adaptation more generally, and highlights where these frameworks are good (green), reasonable (yellow) and poor (red).

Even those areas that were assessed as being strong may potentially be sources of problems from the adaptation perspective. For example, Disaster Risk Reduction approaches are generally strong where they are most relevant – in Bangladesh and India mainly – but they are undermined somewhat by the fact that the human rights frameworks as they relate to internally displaced persons are generally inadequate. So those migrating as a result of disasters may not be protected in the areas they migrate (or are moved) to.

Similarly the extent of policy implementation is often imperfect, with common issues across deltas relating to unrealistic timeframes and inadequate resources (contributing to suboptimal monitoring and evaluation). Policy frameworks for adaptation are not necessarily supported by legal frameworks.

There is increasing evidence of awareness of gender issues in policy making but it is not yet adequate. Female participating in policy-making processes is poor (reiterated by the fact that between 69-89% of respondents on our survey investigating policy implementation barriers were male); the connections between climate change and sectoral vulnerabilities as they differentially affect men and women are not being made; and enforceable implementation of policy objectives on gender is not as good as it might be.

Evaluation of the policy framework for different spheres in each delta

	Human Rights - Gender	Human Rights for Displaced Persons	Natural Resource Mgmt. Ecosystem Approach	Natural Resource Mgmt. Land tenure	Natural Resource Mgmt. Water Resource	Disaster Risk Mgmt. / Response	Climate Change Adaptation
Bangladesh	Good	Poor	Poor	Reasonable	Poor	Good	Reasonable
Ghana	Reasonable	Poor	Reasonable	Poor	Reasonable	Reasonable	Poor
Indian Bengal delta	Good	Reasonable	Reasonable	Good	Reasonable	Good	Poor
Mahanadi	Good	Reasonable	Reasonable	Good	Reasonable	Good	Poor

Good Reasonable Poor

More information:

Ghosh, A.K., Dey, S., Hazra, S.,. 2016. Review of national adaptation policies, India, DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available online at: www.deccma.com

Ghosh, A.K., Hazra, S., Dey, S,. 2016. Review of national adaptation policies, India, DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available online at: www.deccma.com

Hazra, S., Dey, S., Ghosh, A.K. 2016. Review of Odisha State Adaptation Policies, Mahanadi Delta. DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available online at: www.deccma.com

Mensah, A., Anderson, K., Nelson, W., 2016. Review of Adaptation Related Policies in Ghana, DECCMA Working Paper, Deltas, Vulnerability and Climate Change: Migration and Adaptation, IDRC Project Number 107642. Available online at: www.deccma.com

Access to freshwater is a critical challenge in deltas (Photo: Shouvik Das)

FUTURE SITUATION IN DELTAS

Dacope polder in Bangladesh enables farming and fishing (Photo: Nazmul Huda)

IMPACTS OF 1.5°C TEMPERATURE INCREASE

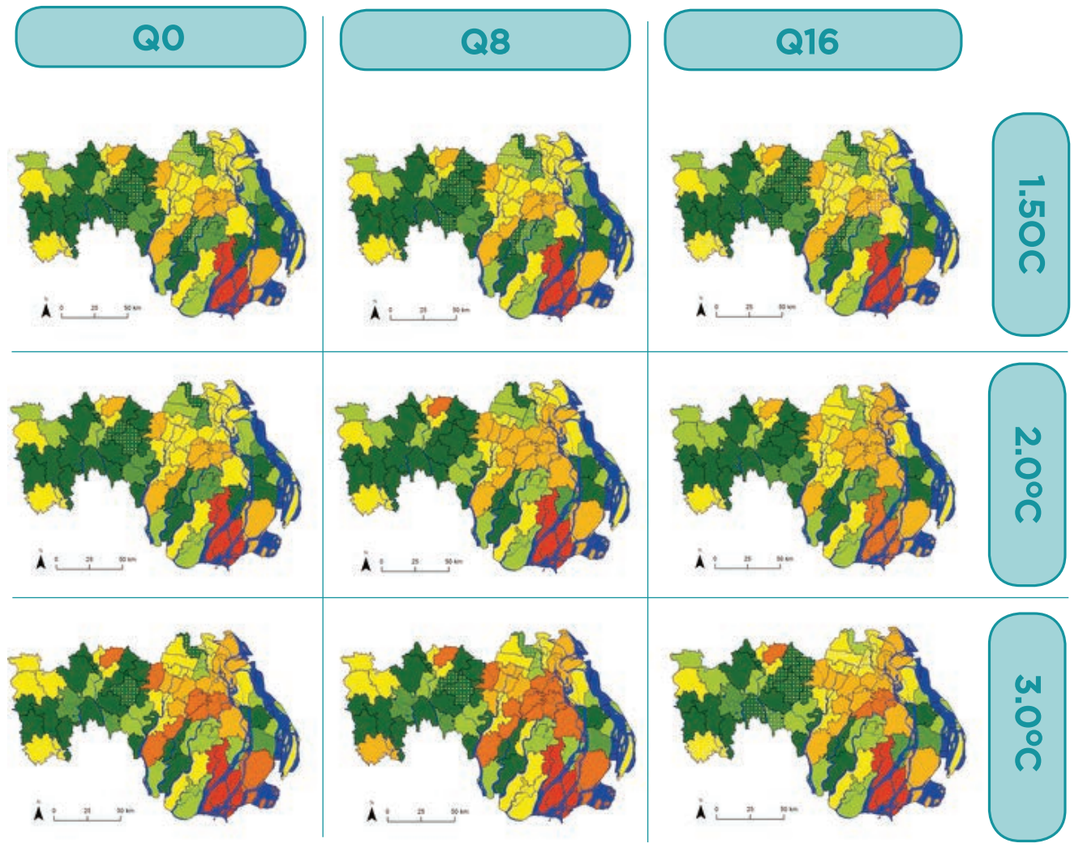
The Paris Agreement commits Parties to the United Nations Framework Convention on Climate Change to limit global average temperature increase to 2°C, with a vision of limiting to 1.5°C. We looked at the likely impacts of sea level rise in Bangladesh depending on how much the global average temperature increases.

We are likely to reach a global average temperature increase of 2°C before 2033. This temperature increase will bring with it an increase in sea level of between 5-14cm. Until 2040 the differences that are likely from a 1.5°C increase and a 2°C increase are indistinguishable largely due to the year on year variability that is already characteristic of deltas.

If the temperature increase reaches 3°C, some of consequences more than double. The area of land flooded is more than 2.5 times greater with a 3°C increase in global temperature than it is if the increase is limited to 1.5°C.

Those at greatest risk in Bangladesh are in the central regions and northeast, where there are fewer polders to protect the land from rising seas. Polders are planned in this area to manage flooding and rising water levels.

Average decadal mean area submerged due to monsoon flooding under a 1.5, 2 and 3°C increase in temperature (assuming no flood protection/adaptation)



More information:
Brown S., Nicholls R.J, Lázár A., Sugata H., Appeaning Addo K., Hornby D.D., Hill C., Haque A,, Caesar J. and Tompkins E., 2018. What are the implications of sea-level rise for a 1.5°C, 2°C and 3°C rise in global mean temperatures in vulnerable deltas? Regional Environmental Change 18(6), 1829-1842, DOI: 10.1007/s10113-018-1311-0

CLIMATE CHANGE WILL LEAD TO SIGNIFICANT ECONOMIC LOSSES BY 2050

In the context of a changing climate, the Computable Generalised Equilibrium (Delta-CGE) model shows the net impacts of shocks on agriculture (losses in terms of land availability and crop yield), fisheries, and infrastructure, with and without adaptation options. In the Mahanadi the main shocks are found in infrastructure, accounting for 11% cumulative loss in GDP per capita, or 0.25% GDP per capita in the whole of India. In the Volta the effects on fisheries are relatively more important, whilst in the Ganges-Brahmaputra-Meghna agriculture is the sector with the biggest economic impacts, accounting for 10% cumulative loss in GDP per capita, or 2% GDP per capita reductions in the rest of the country.

CUMULATIVE LOSS OF GDP PER CAPITA BY SECTOR BY 2050

Delta	Infrastructure	Agriculture*	Fisheries
Mahanadi	11%	2-7%	0.09%
Indian Bengal delta	7%	4-8%	0.33%
Volta	2%	3-7%	0.85%
Ganges-Brahmaputra-Meghna	9%	8-11%	0.36%

* Conditioned on whether CO_2 fertilization and good management practices take place or not.

Fisheries in Bangladesh (Photo: RMMRU)

Preparing ground in the Indian Bengal delta (Photo: Farha Naaz)

MORE ADAPTATION WILL BE NEEDED

Adaptation can effectively reduce the magnitude of projected impacts. For agriculture, embankments and protection and restoration of mangroves could reduce projected economic losses by about 2% in the Indian deltas. In the Volta delta, the effects from the expected shocks on fisheries could be reduced by housing for fisheries, establishment of fish seed hatcheries, and further development of retail fish markets and allied infrastructure.

Early infrastructure protection and capital investment and linked forms of adaptation are effective and less costly than having to remediate post disaster. At household level, the vast majority of adaptations link to accessing loans/ microfinance. Male and female-headed households do not use the same adaptations – recognition of this shows how to support gender-equitable adaptation.

Bangladesh, Ghana and India all have climate change policies in place and have integrated adaptation into other policies and plans to various extents. The recently-approved Bangladesh Delta Plan 2100 is an adaptive delta management planning process that will support adaptation to climate change, and Odisha is finalising the second version of its State Action Plan on Climate Change. DECCMA's results are informing both of these plans.

More information:

Suckall, N., Tompkins, E.L., Nicholls, R.J., Kebede, A.S., Lázár, A.N., Vincent, K., Allan, A., Chapman, A., Rahman, R., Ghosh, T., Hutton, C., Mensah, A. 2018. A framework for identifying and selecting long term adaptation policy directions for deltas. Science of the Total Environment 633, 946-957

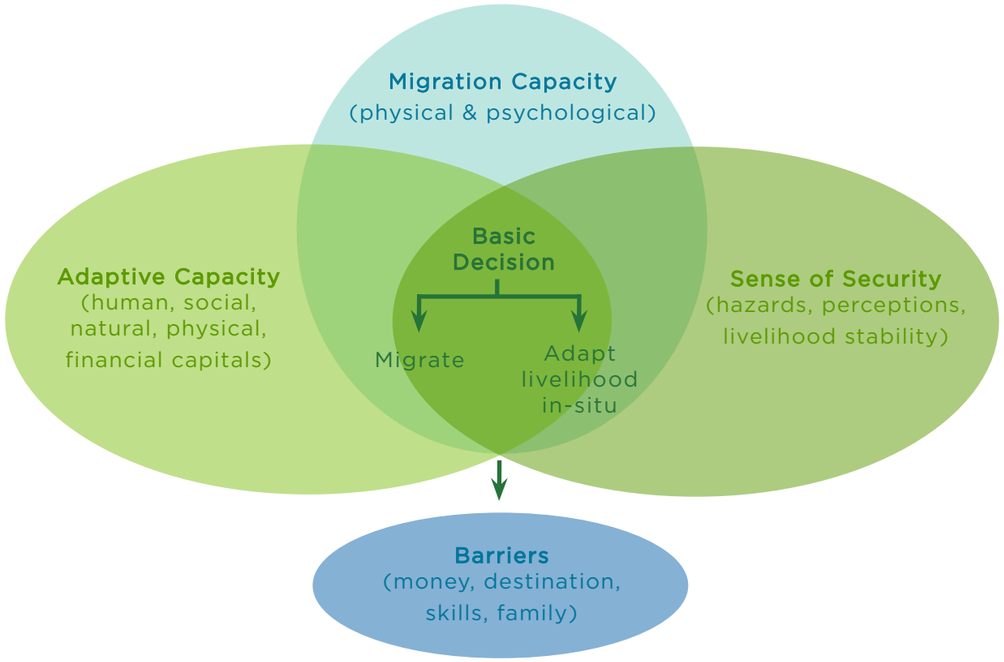
Tompkins, E.L., Vincent, K., Nicholls, R.J., Suckall, N. 2018. Documenting the state of adaptation for the global stocktake of the Paris Agreement. WIREs Climate Change c545.

Brick embankments to protect delta land (Photo: DECCMA)

Increasing opportunities exist for women in formal sector employment, such as in this biscuit factory in Dhaka (Photo: DECCMA Bangladesh)

MODELLING WHAT DETERMINES ADAPTATION DECISIONS

We have developed a Bayesian network model for coastal Bangladesh that models with good accuracy the relative influence of household structure, mobility, remittances and environmental stress on household decision-making (focusing on adaptation and migration), and the mediating influence of the gender of the household head. This helps us to understand what could be done to improve the likelihood of households adapting in-situ, taking into account the different factors that affect decisions of male- and female-headed households.



The drivers that affect the decision to adapt livelihoods in-situ or migrate

INFLUENTIAL DRIVERS OF ADAPTATION DECISIONS BY MALE- AND FEMALE-HEADED HOUSEHOLDS

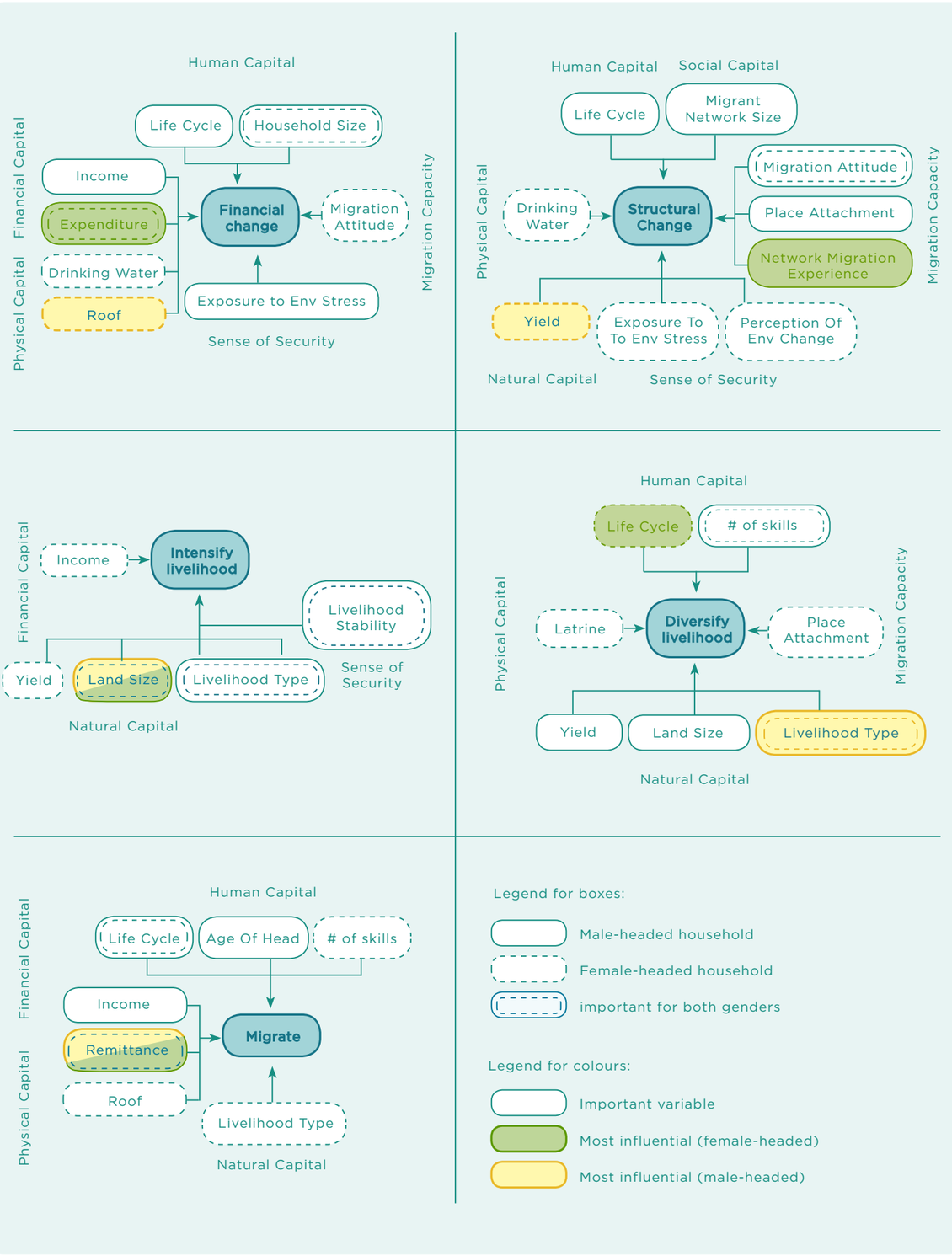
The model shows that the conditions under which individuals use migration as an adaptation to environmental risk are socially differentiated and contextually contingent. These conditions can be described by financial, physical, natural, human, social and psychological indicators describing the adaptive capacity, migration capacity and sense of security of the household.

In-situ livelihood adaptations (such as intensification and diversification of crops) are dominantly natural capital and environmental security-related. On the other hand, migration decisions are deeply rooted in financial and human capitals. Interestingly, environmental hazards are only important for financial and structural adaptations. However, hazards and environmental changes have an indirect effect on all decisions through affecting total income and through livelihood potential (i.e. yield and livelihood stability).

There are important gender differences in what drives decisions for male- and female-headed households. Even though wealth is important for both household types, when adaptation decisions are made by male-headed households they are influenced by cash flow (income/expenditure-based financial capital), whereas for female-headed households every single decision is associated with physical capital indicators (e.g. material of roof). Since incomes and expenditures can be highly variable, this means that adaptive responses by male-headed households are contingent upon sufficient access to financial capital. On the other hand, female-headed households make more conscious decisions based on their long-term

financial capabilities (i.e. asset quality) and have lower numbers of recorded adaptations.

Human capital is an important factor affecting household decisions for both male- and female-headed households, but in different ways. For male-headed households, the household structure and the age of head are most important, whereas for female-headed households their number of skills and the household size are most influential. This shows that male-headed households probably adapt more easily as time progresses purely based on their lifecycle (that also correlates with age of head). On the other hand, female-headed households have important barriers to adaptation such as gender roles in the household and community, and also more limited skillsets.



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Lazar, A.N., Adams, H., Safra de Campos, R. Vincent, K., Nicholls, R.J., Adger, W.N., Rocky, M.H. 2018. How gender affects household decisions to adapt or migrate due to environmental risk: A Bayesian network model for coastal Bangladesh. In preparation.

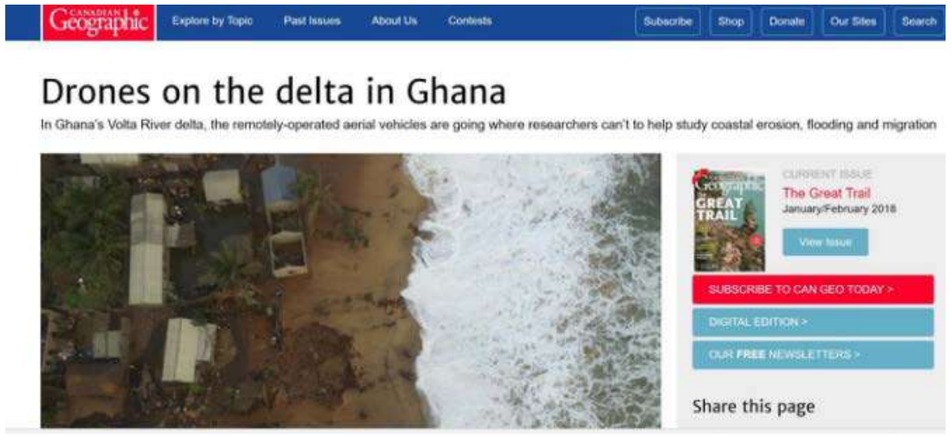
ENGAGEMENT AND IMPACT

DECCMA Bangladesh team presents research outputs to Professor Shamsul Alam, Member Secretary, General Economics Division, Planning Commission, Bangladesh

RAISING THE PROFILE OF DELTA RESIDENTS WITH PARLIAMENTARIANS (VOLTA)

Rates of coastal erosion in the Gulf of Guinea (including in the Volta delta) are significant, and up to 8m per year in places. In places where there are no structural adaptations in place, the rapidly eroding coastline creates pressures for delta residents whose houses and land are regularly flooded or destroyed. The DECCMA Ghana team, under the leadership of Professor Kwasi Appeaning-Addo, has been using drones to monitor coastal erosion and flooding in the delta. Residents of affected districts have long lobbied for coastal protection or resettlement options. The powerful visual imagery of flooding has been sufficient to motivate the Keta MP to take up this issue in the District Assembly, where options are currently being considered.

This work has been highlighted in features in Canadian Geographic, Scidev.net, and presented to the Forum of the Standing Committee on Finance of the UNFCCC in September 2016.



INPUTS TO THE COASTAL DEVELOPMENT AUTHORITY BILL (VOLTA)

Section 4(1)(i) of Act 961 (Coastal Developent Authority), assented on January 2, 2018, states the requirement that "two persons with relevant expertise in coastal development should be nominated as members of the board".

Parliamentarian Hon. Clement Humado is the chair of the DECCMA Ghana National Expert Advisory Group and a member of the Parliamentary Select Committee on Environment, Science and Technology.

The Bill seeks to establish a Coastal Development Authority to provide a framework for enhanced and coordinated economic and social development of the districts and communities within the coastal areas of Ghana namely, which includes the Volta delta.

In a submission, Hon. Humado noted that, since there are experts in coastal development and population studies in the tertiary institutions (specifically the University of Ghana), they should be included on the Authority's Board. Subsequently in section 4(1)(i) this was included.

REQUESTED TO PROVIDE INPUTS TO POLICY AND HIGHLIGHTING DELTA MIGRATION (MAHANADI)

DECCMA is committed to providing policy support to create the conditions for sustainable, gender-sensitive adaptation in deltas. The DECCMA India team in the Mahanadi delta, through consortium members Sansristi and the Chilika Development Authority, has actively engaged with stakeholders in the Odisha state government.

As a result of this engagement, the DECCMA India team was invited to provide comments into the second Odisha State Action Plan on Climate Change 2018-23. Whilst gender was minimally considered, as a result of DECCMA's inputs and research findings the plan now contains a separate chapter on gender.

Through its engagement with government, DECCMA has also provided inputs on climate change perspectives to the draft versions of the National Policy on Empowerment of Women 2016 and highlighted the importance of delta out-migration. Prior to DECCMA's research it was assumed that migration only occurred in the western drought-prone districts with migration to the fertile delta land for agriculture near the coast. In fact all rural areas in the Mahanadi are losing people.

More information:
DECCMA's contribution to the change in the content of the Action Plan (https://youtu.be/hGYu1qcSpAE)

Fishing boats in the Mahanadi delta (Photo: Andrew Allan)

PARTNERSHIP WITH THE WEST BENGAL STATE DEPARTMENT OF ENVIRONMENT (INDIAN BENGAL DELTA)

The West Bengal State Department of Environment was significantly convinced of the importance of vulnerability, migration and adaptation to jointly host a stakeholder workshop with DECCMA (and this brought increased attendance of other government departments).

Indian national stakeholder workshop, November 2014

CAPACITY BUILDING

Building the capacity of early career researchers has been a priority for DECCMA. Throughout the lifetime of the project, 16 men and 17 women have undertaken postgraduate studies for Masters or Doctoral degrees as part of the project, and many more have gained experience as research assistants.

Specialist training has been run under several themes, from land cover mapping (by FAO), to input-output economics (by the BC3 Basque Centre for Climate Change), and the development of Bayesian network models and integrated assessment models (by the University of Southampton). Exchange and field visits have also taken place among all the research teams.

Early career researchers have been encouraged to present their work in fora both within and outside the consortium. Poster competitions were held during our six monthly consortium meetings, with prizes that included support for international conference attendance. Over two thirds of conference papers by the DECCMA India team were presented by early career researchers.

DECCMA team members have won competitive funding to develop their research skills, either through full time studies, summer schools, or exchange visits. Mohammad Rashed Bhuiyan was awarded a Commonwealth Shared Scholarship to study for an MSc in Sustainable Development at the University of Exeter in the 2018-19 academic year. Shouvik Das was selected to participate in the Hugo Observatory EDGE Summer School on environmental changes and migration. DECCMA India coordinator Sumana Banerjee won an IDRC Climate Change Leaders Award and spent three weeks in the UK to develop her project management and research communication skills to support climate change research in India.

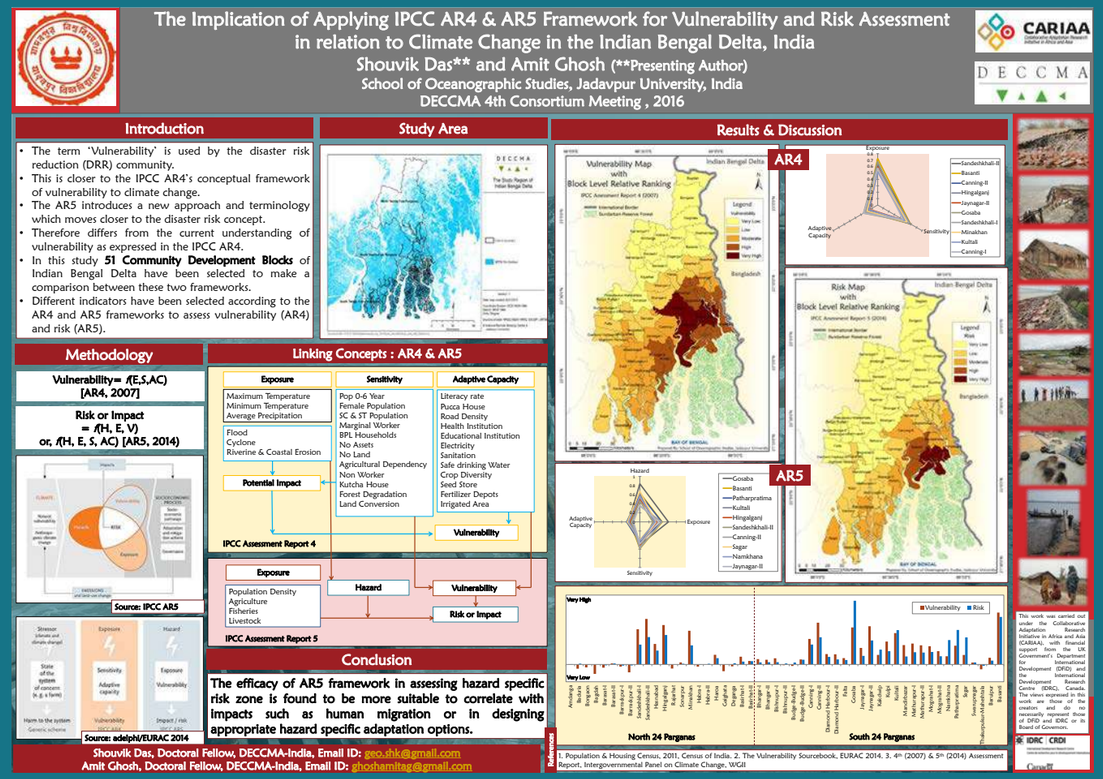
DECCMA PhD graduates are continuing their research careers: for example Dr Kwame Owusu-Daaku is an assistant professor at the University of West Florida; and Dr Gregory Cooper has a postdoctoral research position at the School of African and Oriental Studies, University of London.

Selected postgraduate theses include:

- Gender, vulnerability to environmental change and migration in the Volta delta, Ghana (PhD, Donatus Yaw Atiglo)
- Sea defence systems as an adaptation to climate change in the Volta River delta, Ghana (PhD, Kwame Owusu-Daaku)
- Investigation on polderization-induced water logging and feasible adaptation measures within Dumuria Upazila under Khulna District, Bangladesh (MSc, Shanjida Noor)
- Potentiality of sediment flux to offset relative sea level rise in the Ganges-Brahmaputra-Meghna delta (MSc, Mahmida Tul Urmi)
- Socio-ecological tipping points in world deltas (PhD, Gregory Cooper)

DECCMA research has helped to shape the ongoing agenda of sustainability science and built the capacity for ongoing interdisciplinary engagement. Continuing funded research, for example, focuses on the role of new migrant populations in planning for safe and sustainable cities. This work is focussed on Chattogram in the delta of Bangladesh and involves the University of Exeter with University of Dhaka DECCMA partners and is funded by UK ESRC and DFID under their Development Frontiers programme. Further global research on the fundamental relationship between migration, mobility and sustainability is being funded by an international research programme on Transformations to Sustainability and involves partners from Exeter, Dhaka and Ghana with international partners in the US, Sweden, Netherlands and Belgium.

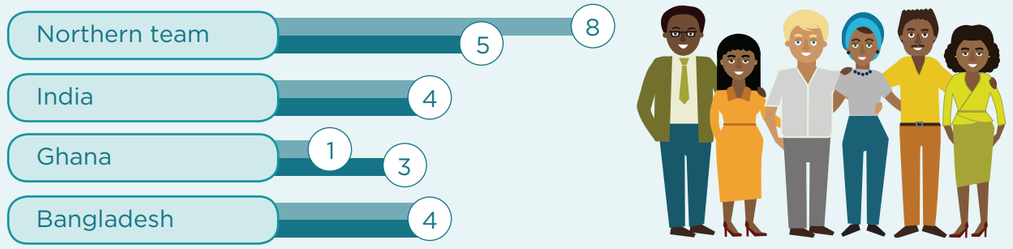
A DECCMA researcher presents his poster at the 4th consortium meeting, Southampton, January 2016



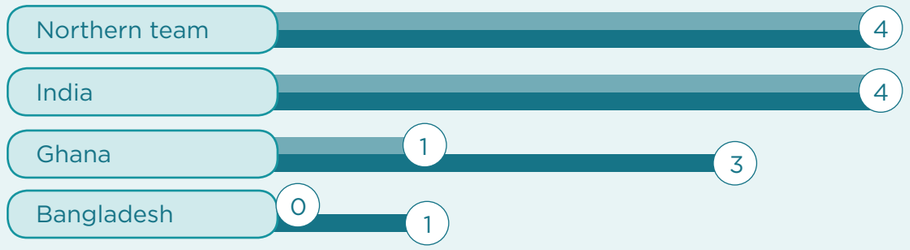
Prize winning poster at the 4th consortium meeting, Southampton, January 2016. The paper arising out of this research is currently under review with Science of the Total Environment.

CAPACITY BUILDING

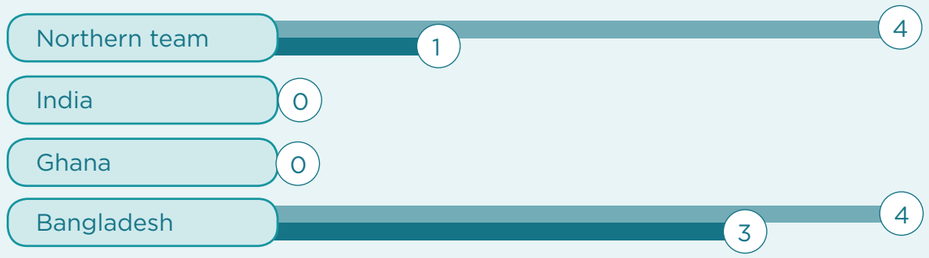
TOTAL RESEARCHERS PER RESEARCH TEAM



PhD RESEARCHERS



MSc RESEARCHERS



JENNIFER AYAMGA, PhD STUDENT, UNIVERSITY OF GHANA

As a DECCMA team member, Jennifer's research has centred on integrated analysis of the impact of climatic and non-climatic factors on agricultural livelihoods in the Volta Delta. "The objective is to understand agro-ecological systems in the delta in the context of transformational changes in climatic and non-climatic systems. Based on this understanding, I am developing a model that will predict the impacts of climate change and non-climatic determinants of agricultural livelihood in the Volta delta. The model should help vulnerable people adapt their practices to the changing scenarios of both climatic and non-climatic determinants of crop production and inform policy formulation," she says. To ensure that her research is used by the target audience, she has been adopting DECCMA's approach of involving key stakeholders from the beginning to the end of her research process.

On her broader DECCMA experience, Jennifer says, "Working with DECCMA has been a great opportunity for me to grow and learn. I have been mentored by highly qualified scientists in different fields, who are passionate about what they do. It has really had a positive impact on me." She has also had the opportunity to attend training on modelling techniques in Ghana, the UK and Bangladesh. These training sessions have helped her to refine the theoretical foundation of her research and develop essential technical skills.

Looking to the future, Jennifer's long-term goal is to be a faculty member at a university in Ghana, where she can use her skills to teach, research, and mentor students. "Through my involvement with DECCMA I have developed a deep interest in understanding the vulnerabilities of communities and related livelihoods systems to climate change and adaptive capacity for resilience. I would be immensely gratified to contribute to building knowledge in these areas."

SHOUVIK DAS, PhD STUDENT, JADAVPUR UNIVERSITY INDIA

Shouvik Das is a PhD student at Jadavpur University in Kolkata, investigating environmental change, vulnerability and migration. There are uncertainties in how the scale and nature of environmental migration may vary in the future, and how this is different from migration driven by economic, political or socio-cultural reasons. "My PhD research attempts to unpack this by tracking migrants from the sending areas to the receiving areas through household surveys. The study combines secondary data analysis along with application of geo-informatics and modelling to develop appropriate criteria to examine the relationship between the environment and migration", he says.

As well as undertaking his own research, Shouvik has had the opportunity to present my work in international conferences (including Adaptation Futures 2018 in Cape Town), participate in a summer school on environmental changes and migration, and be a part of several cross-CARIAA annual learning reviews. He has played a key role in the DECCMA team, with particular involvement in the migration work package. He says "I have contributed towards demographic analysis, production of vulnerability and risk maps, survey design and implementation, qualitative and quantitative data analysis, and preparation of working papers and peer reviewed journal articles."

Shouvik highlights that "being part of an international research project like DECCMA project enabled me to learn from and collaborate with leading researchers in the fields of migration, vulnerability and global environmental change from international universities and institutions". The knowledge, skills and network will likely help him achieve his future ambition of progressing his academic career in an international university as a post-doctoral researcher after submission of his PhD.

PROFESSIONAL TRAINING, SUMANA BANERJEE, DECCMA INDIA COORDINATOR

"Management appeals to me and working for a research project has provided an added bonus since the scope of learning is vast – learning from the research, exchanging lessons within team members, and learning from the community. DECCMA has been a learn-as-you-go experience where I have learnt a lot but often wondered if formal training could make things easier for me.

In June 2017 I had the opportunity to undertake such training in project management, communications and research for impact during three weeks at the Universities of Southampton and Exeter in the UK through an IDRC Climate Change Leaders Award.

I have learnt ways how to better work in teams and extract the best out of teamwork. This training has opened more structured and planned approaches which can be adopted not only for managing projects but for personal use as well. I have been initiated into the ways of motivating researchers to filter out key messages from their research and fine tuning those for communication to stakeholders. I have also subsequently obtained my PRINCE2 Foundation & Practitioner 2017. Overall, I feel more confident managing a research team after undergoing this training.

Climate change is affecting environmental systems globally and India being geographically diverse is no exception. To tackle the wrath of climate change, research and action projects are seeing the light of the day. I wish to implement the lessons from this activity by working as a project manager in other climate change research projects in the future."

OUTPUTS

(for updates see www.deccma.com)

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DECCMA TEAM MEMBERS

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