Synergies and trade-offs for the SDGs in a deltaic socio-ecological system: Development of an Integrated Assessment Model

Marcinko C., Harfoot A., Daw T., Clarke D., Hazra S., Hutton C., Hill C., Lazar A., Nicholls R.

Sustainable Development Goals (SDGs)

United Nations 2030 Agenda for Sustainable Development

- 17 Sustainable Development Goals (SDGS)
- 169 targets
- Urgently needed to shift the world to a sustainable and resilient path.

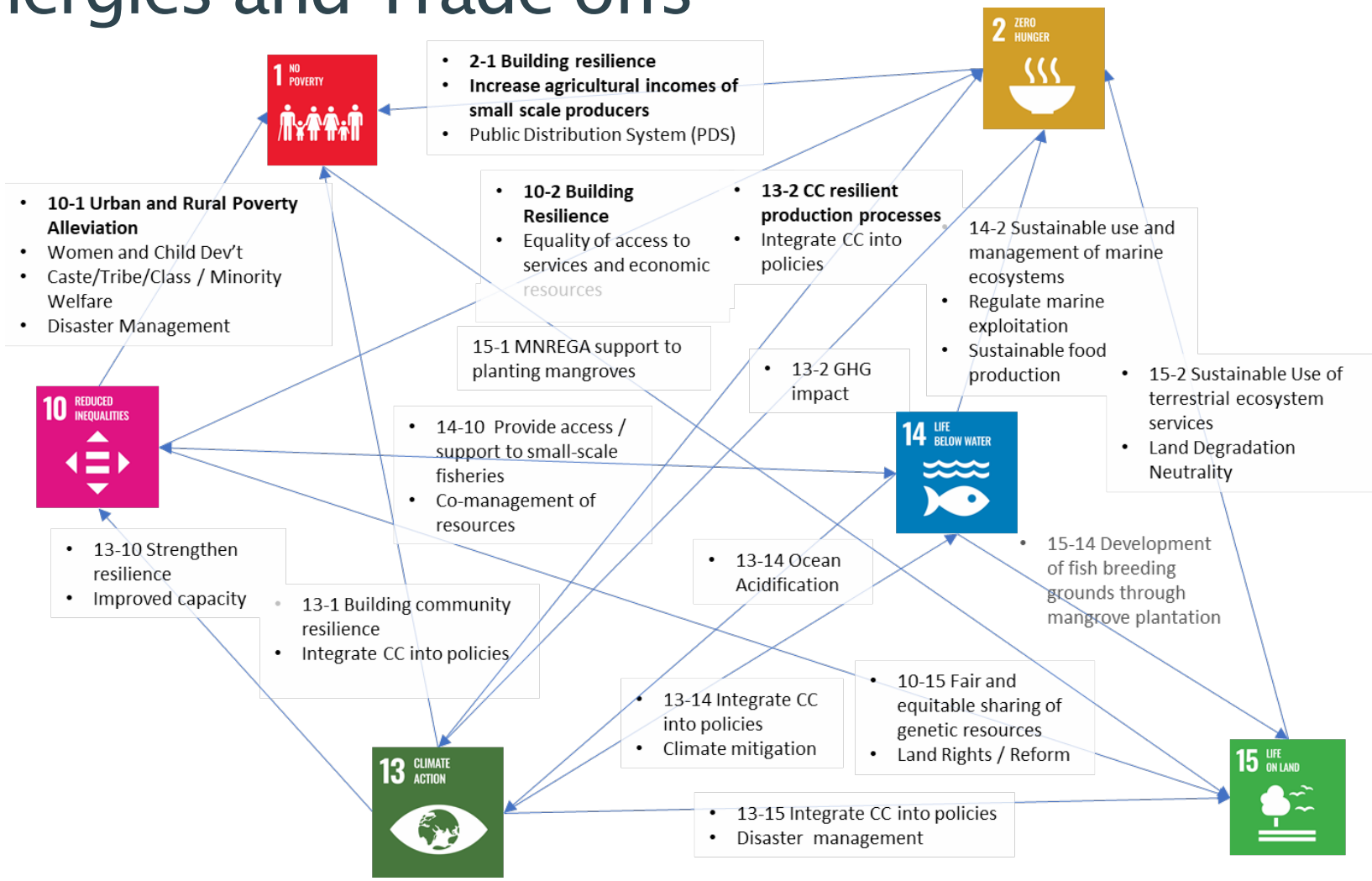
SDGΔ Project Aim: Build on earlier delta research and explore development trajectories, trade-offs and choices raised by six (of the 17) SDGs:

SDG Interactions: Synergies and Trade-offs

Interactions can lead to interventions which have synergies and trade-offs between SDGs.

Understanding synergies and trade-offs is critical to achieve the 2030 Agenda

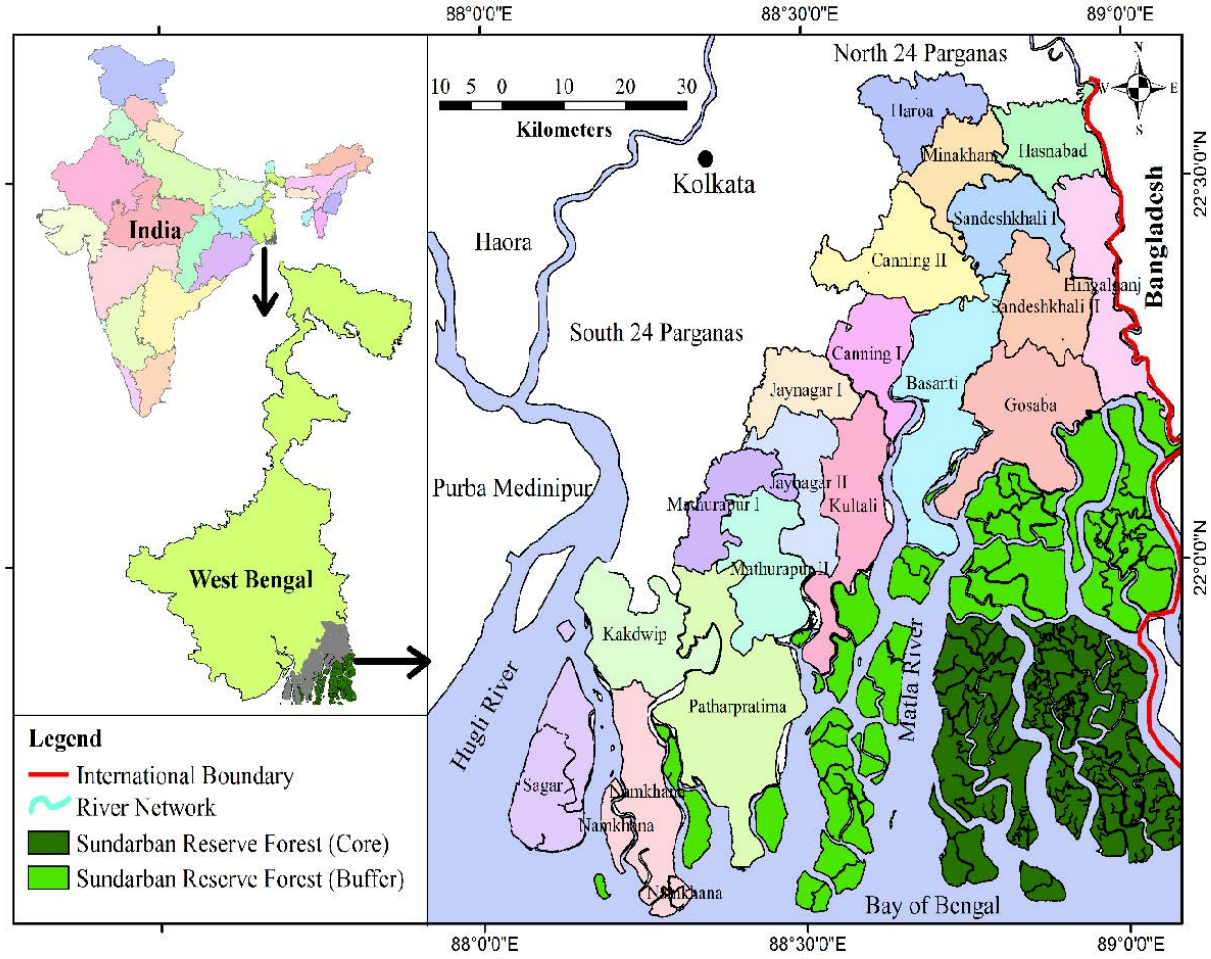
We are identifying and analysing relationships between SDGS and the links to policy at a **sub-national and regional scales**.



Example of the relationships between SDGS and links to potential policy interventions

Study Area: Sundarbans Biosphere Reserve (SBR)

- Area of 9630 km^2 covering the Indian Sundarbans on the Ganges Delta
- UNESCO World Heritage Site
- Region of ecological importance
  - Large mangrove forest
  - Home to 96+ tigers
  - Biodiversity hotspot



Map of study area

Study Area: Sundarbans Biosphere Reserve (SBR)

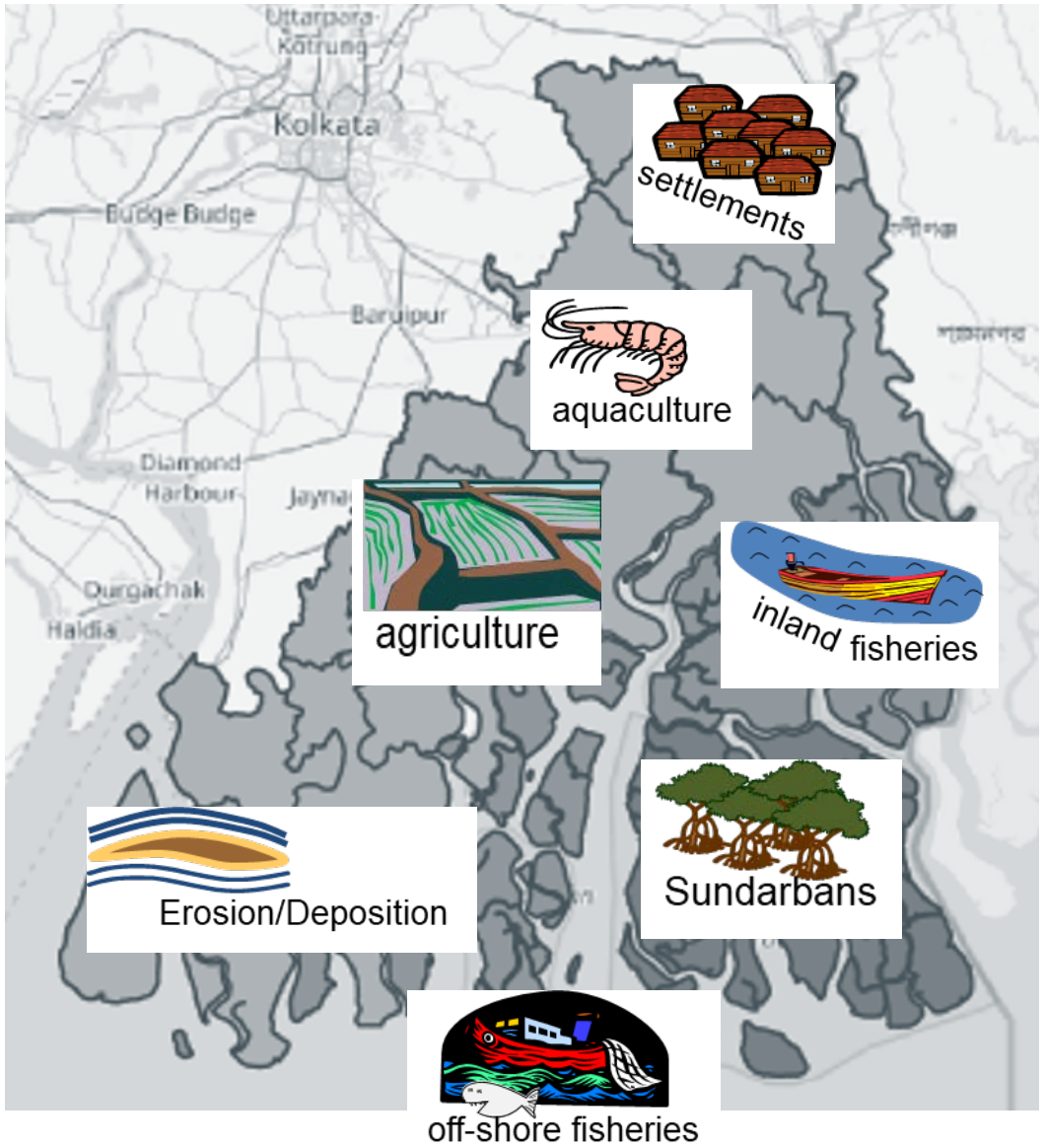
- Home to > 5 million people
- 32 % live below the poverty line
- 60 % of workers depend on agriculture
- Fisheries is an important occupation
- Increasing conversion of land to aquaculture

Important livelihoods in the SBR:
Agriculture, Fisheries and Aquaculture

Drivers of Change in the SBR

- Exogenous factors
  - e.g. Climate Change, Natural Hazards, Upstream river management, Macro-economics (e.g. globalisation, technological change) etc.
- Endogenous factors
  - e.g. Ground water withdrawal, population change, Subsidies, Infrastructure development, Conservation etc.

Exogenous and endogenous drivers, influenced by government policy, impact land use and land cover within the SBR and drive changes in the livelihoods and wellbeing of local communities.



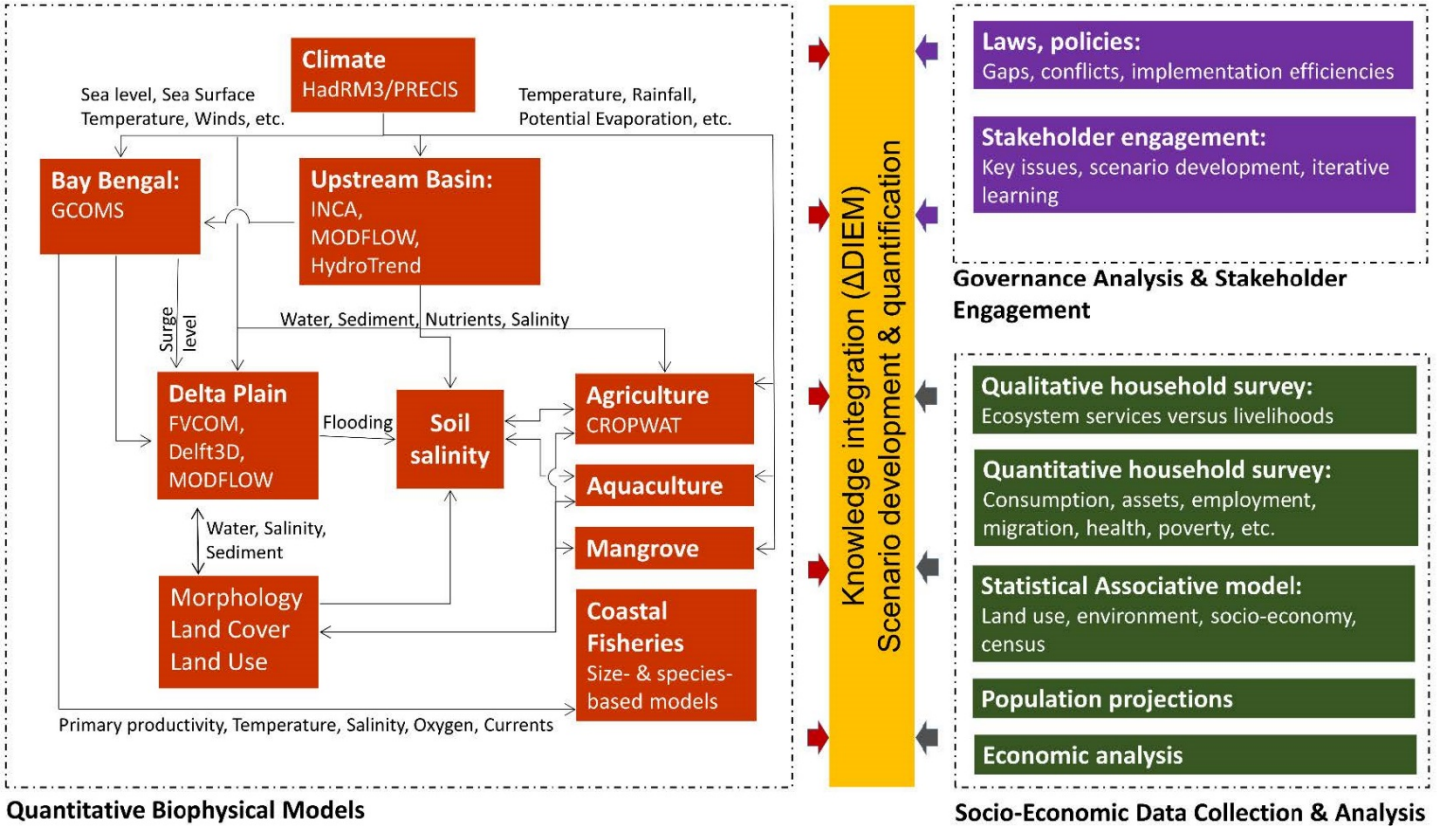
Example of Land Use/Land Change Processes in SBR

Stakeholder Engagement

- Two workshops with local government, NGOS, community leaders
- Identified key drives that will affect sustainable development in the Sundarbans Biosphere Reserve
- Identified the perceived importance of these drivers and how they may change into the future

Delta Dynamic Integrated Emulator Model (ΔDIEM) Framework

- ΔDIEM is an Integrated Assessment Model (IAM) linking biophysical, socioeconomic and governance processes for rural communities.
- Developed during a large 5 year project (ESPA Deltas) for coastal Bangladesh
- Provides a Starting Point: the ΔDIEM framework includes many of relevant processes for SDG Deltas and has been applied in a similar landscape.



Schematic of ΔDIEM Framework. This IAM was used to analyse potential effects of development policies on rural livelihoods under future climate change and socioeconomic scenarios in coastal Bangladesh (Nicholls et al 2016, 2018; Lazar et al 2018).

Challenges: Data, Data and more Data…

- IAMs are data hungry and ideally require extensive qualitative and quantitative data for:
  - Accurate understanding of system processes and their interactions
  - Development, calibration and validation of (sub) process models
- Limited baseline data across the SBR
  - Hampers full characterisation of some biophysical and socioeconomic processes.
  - Restricts which processes can be included within an IAM

Example impact of data limitation: Characterising aquaculture and predicting future trends

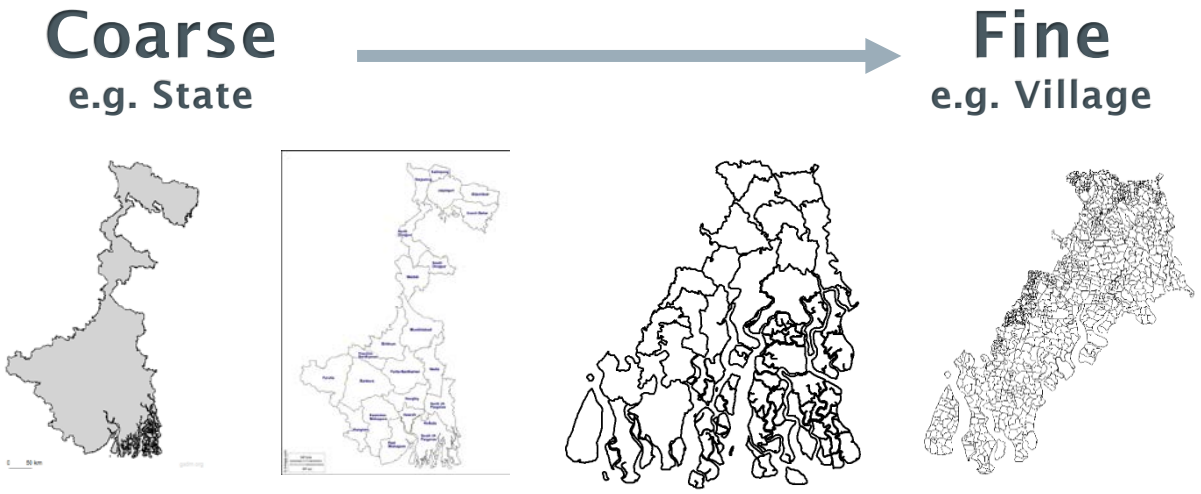
Aquaculture sites can be detected from Remote Sensing, but information on what is being farmed and water source (fresh or brackish) is more elusive.

Lack of data restricts knowledge of how aquaculture is contributing to livelihoods and food security, and how they may change, expand or be abandoned in the future.

SDG Delta is conducting local surveys to better understand aquaculture practices and other socioeconomics factors within the SBR

Challenges: The Issue of Scale

- IAM represent complex biophysical and socioeconomic systems
- IAMs integrate processes that occur across multiple scales of space and time.
  - Spatial resolution of predictions depend on the data available to force models.
  - Different models run on different temporal scales e.g. Agricultural models = daily timestep; socioeconomic models = monthly timestep or longer.



Data for model forcing are available at differing spatial resolutions

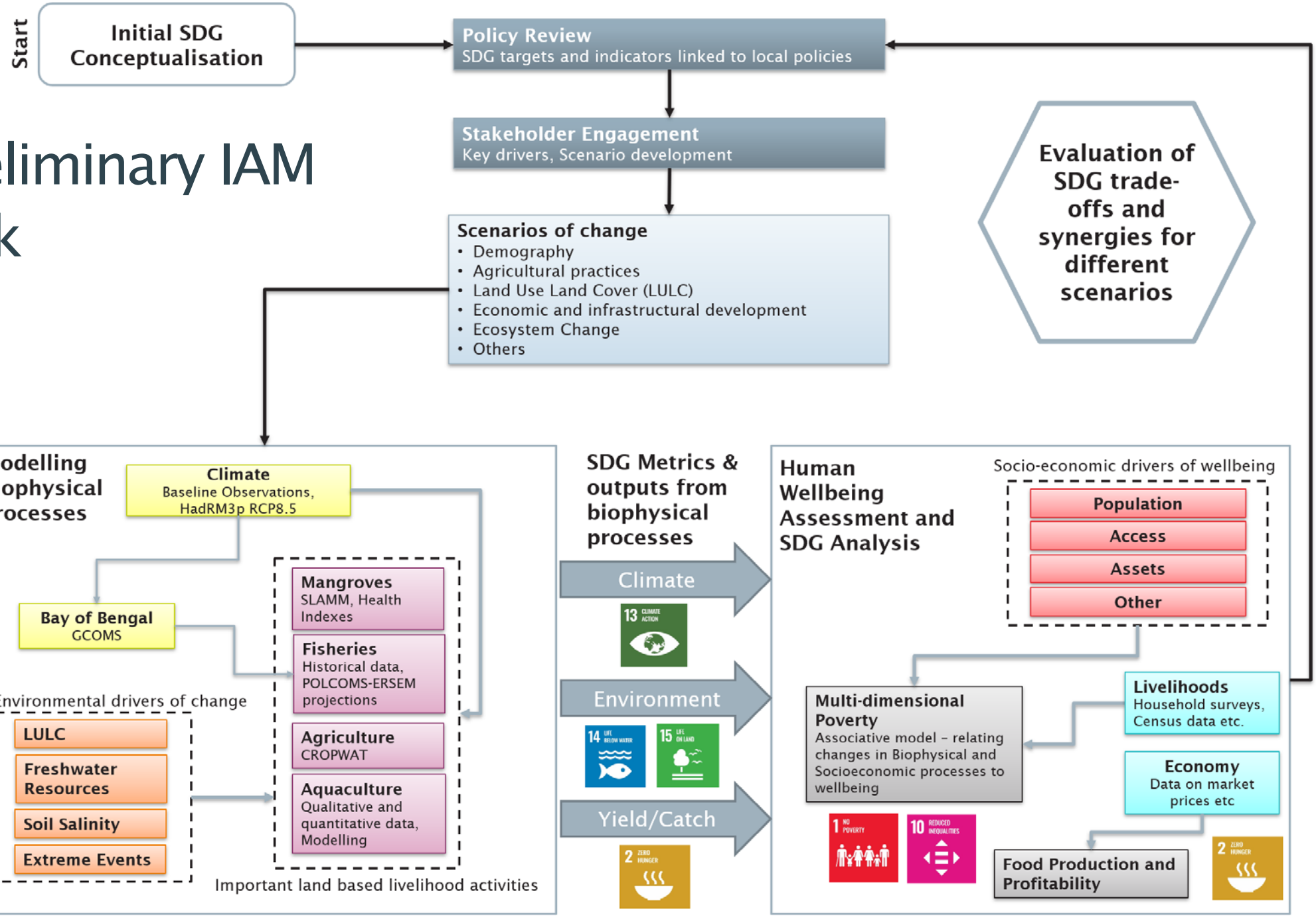
Other Challenges

- Consistency needed between sub-models for prediction into the future
  - Biophysical models must be forced by the same climate scenario/s (e.g. RCP 8.5, SRES Q16 etc.)
- Project time constraints.
  - Relatively short project (project ends 2021) limits time for new sub-model development and collection and analysis of in situ data.
- Understanding modelled outputs in relation to SDG metrics

SBR - Integrated Assessment Model Development

- Stakeholder and expert knowledge used to
  - Identify important environmental drivers of change
  - Identify important livelihood strategies
  - Understand the links between human and natural systems specific to the study area
  - Develop policy and future scenarios of interest
- Reviewed data and sub-model availability
- Identified data and knowledge gaps
- Development of a preliminary framework for understanding SDG trade-offs and synergies in the SBR

SDGΔ - Preliminary IAM Framework



What Next…

- Further research to understand SBR human-natural system
  - Household surveys (currently on hold due to COVID-19)
  - In situ data collection to support modelling of biophysical processes (soil, river salinity, bathymetry etc).
  - Calibration and validation of sub-models (EX-CROPWAT, SLAMM, Associative model etc).
- Refine, set up and test IAM framework.
- Building policy and future development scenarios of interest to stakeholders
- Demonstration of IAM framework to investigate impact of scenarios on ecological and socioeconomic processes and relate these to SDG trade-offs and synergies.

References

- Lázár, A. N., Payo, A., Adams, H., Ahmed, A., Allan, A., Akanda, A. R., Amoako Johnson, F., Barbour, E. J., Biswas, S. K., Caesar, J., Chapman, A., Clarke, D., Fernandes, J. A., Haque, A., Hossain, M. A. R., Hunt, A., Hutton, C. W., Kay, S., Mukhopadhyay, A., … Whitehead, P. G. (2018). Integrative Analysis Applying the Delta Dynamic Integrated Emulator Model in South-West Coastal Bangladesh. In R. J. Nicholls, C. W. Hutton, W. N. Adger, S. E. Hanson, M. M. Rahman, & M. Salehin (Eds.), *Ecosystem Services for Well-Being in Deltas: Integrated Assessment for Policy Analysis* (pp. 525–574). Springer International Publishing. https://doi.org/10.1007/978-3-319-71093-8_28
- Nicholls, R. J., Hutton, C. W., Lázár, A. N., Allan, A., Adger, W. N., Adams, H., Wolf, J., Rahman, M., & Salehin, M. (2016). Integrated assessment of social and environmental sustainability dynamics in the Ganges-Brahmaputra-Meghna delta, Bangladesh. *Estuarine, Coastal and Shelf Science*, *183*, 370–381. https://doi.org/10.1016/j.ecss.2016.08.017
- Nicholls, R. J., Hutton, C. W., Lázár, A. N., Neil Adger, W., Allan, A., Whitehead, P. G., Wolf, J., Rahman, M. M., Salehin, M., Hanson, S. E., & Payo, A. (2018). An Integrated Approach Providing Scientific and Policy-Relevant Insights for South-West Bangladesh. In R. J. Nicholls, C. W. Hutton, W. N. Adger, S. E. Hanson, M. M. Rahman, & M. Salehin (Eds.), *Ecosystem Services for Well-Being in Deltas: Integrated Assessment for Policy Analysis* (pp. 49–69). Springer International Publishing. https://doi.org/10.1007/978-3-319-71093-8_3

Synergies and trade-offs for the SDGs in a deltaic socio-ecological system: Development of an Integrated Assessment Model

Marcinko C., Harfoot A., Daw T., Clarke D., Hazra S., Hutton C., Hill C., Lazar A., Nicholls R.