DECCMA

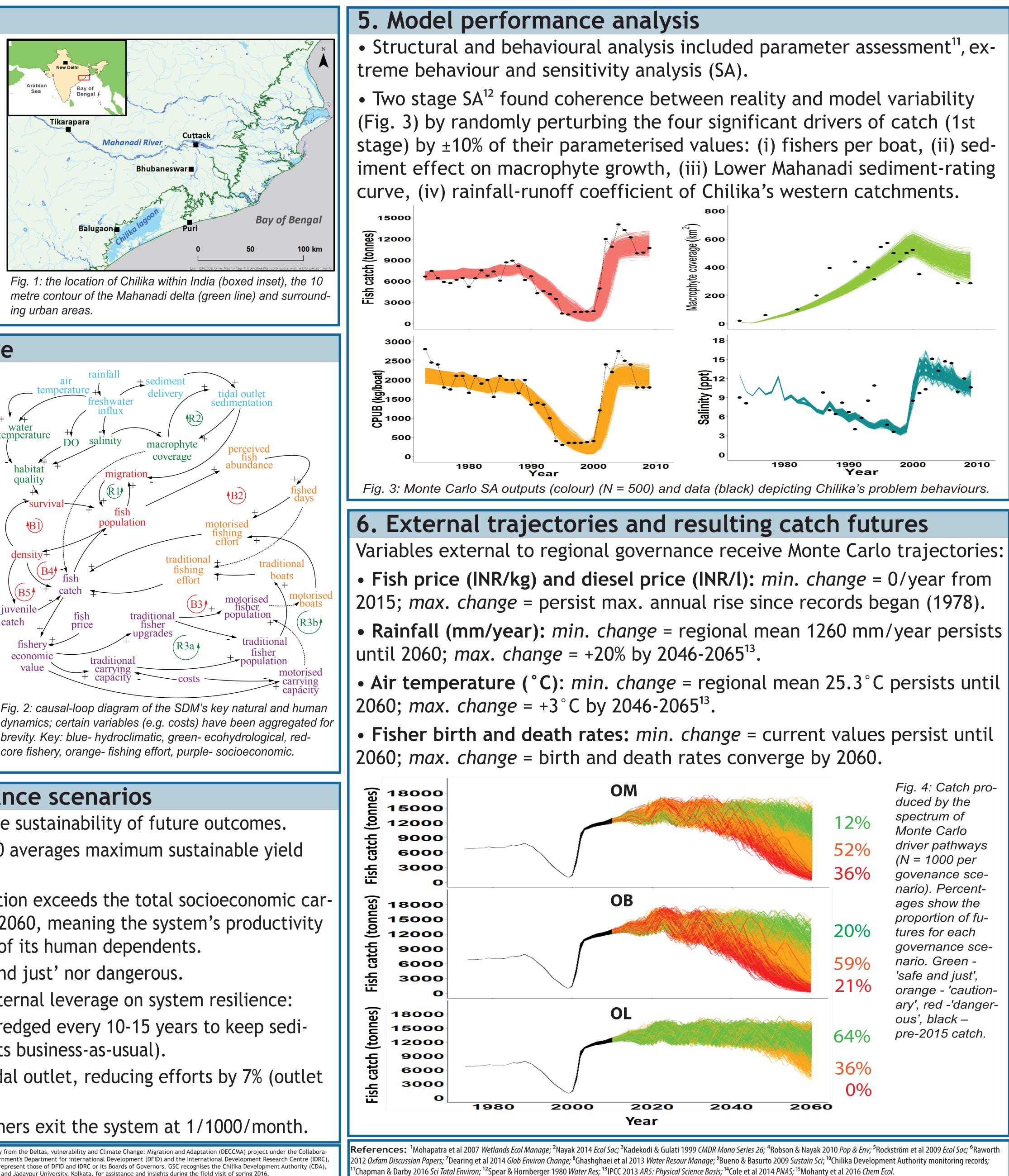
Designing a 'safe and just operating space' for the Chilika lagoon fishery of the Mahanadi delta, India CARIAA IRCAAA Southampton UKAIC 🗱 IDRC CRDI

Gregory Cooper^a and John Dearing

• A system dynamics model (SDM) projects thousands of plausible futures for a regional natural resource system.

2. Study background

The Chilika lagoon (Fig. 1) fishery is valued at US\$25 million/yr, supporting 35,000 fishers and 200,000 dependents¹. Catch fell from 7200 tonnes/yr (1980s) to 3100 tonnes/yr (1990s), affecting various aspects of the system, including fisher income², exports³ and human migration⁴. Despite recovery after tidal outlet reopening in 2000, the system's future is uncertain under plausible natural and socioeconomic changes.



3. Model purpose and structure

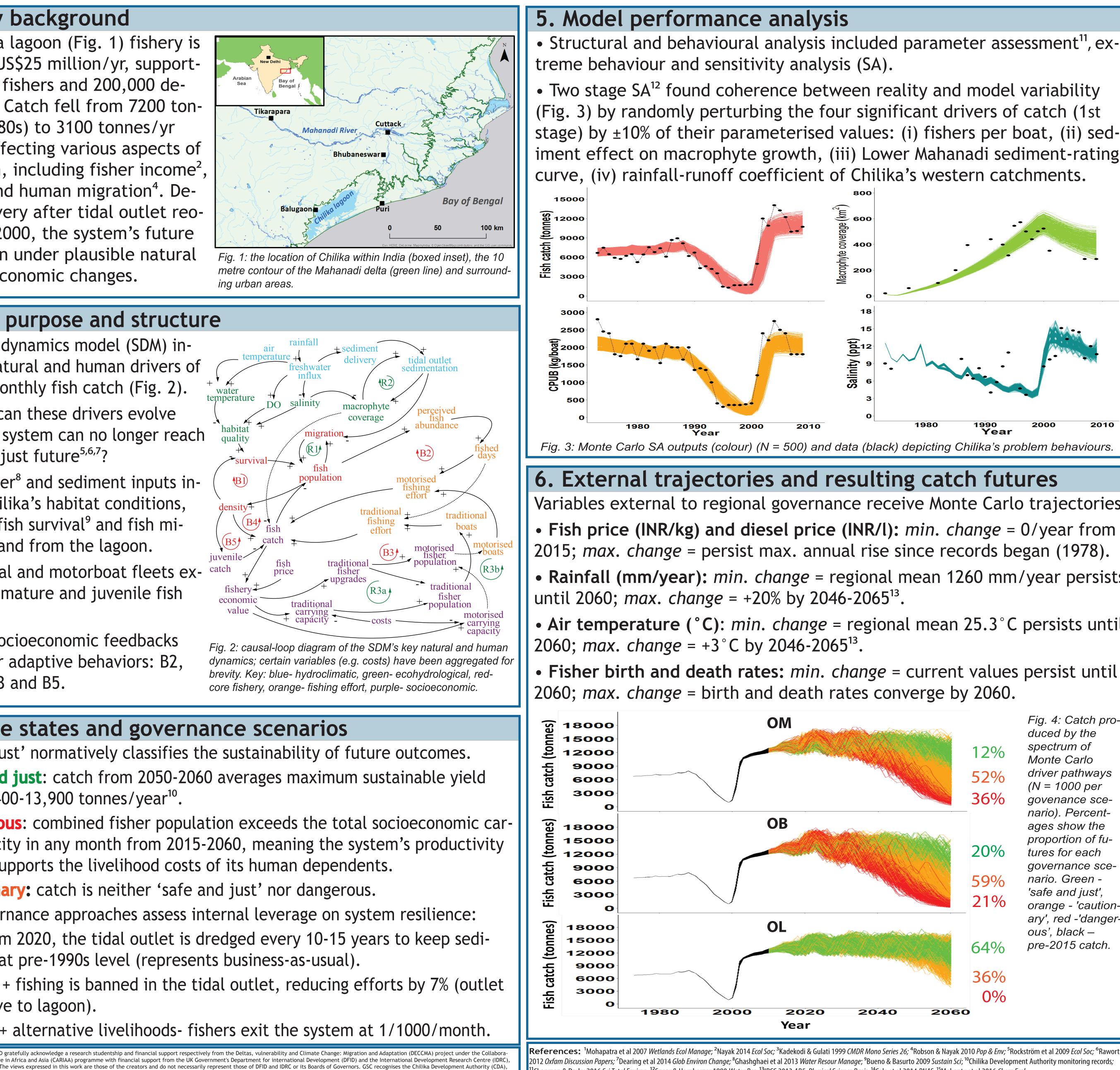
• A system dynamics model (SDM) integrates natural and human drivers of Chilika's monthly fish catch (Fig. 2).

• How far can these drivers evolve before the system can no longer reach a safe and just future^{5,6,7}?

• Freshwater⁸ and sediment inputs influence Chilika's habitat conditions, modifying fish survival⁹ and fish migration to and from the lagoon.

• Traditional and motorboat fleets extract from mature and juvenile fish stocks⁹.

• Various socioeconomic feedbacks drive fisher adaptive behaviors: B2, R3(a/b), B3 and B5.



4. Future states and governance scenarios

'Safe and just' normatively classifies the sustainability of future outcomes. • **Safe and just**: catch from 2050-2060 averages maximum sustainable yield (MSY): 11,400-13,900 tonnes/year¹⁰.

• **Dangerous**: combined fisher population exceeds the total socioeconomic carrying capacity in any month from 2015-2060, meaning the system's productivity no longer supports the livelihood costs of its human dependents.

• Cautionary: catch is neither 'safe and just' nor dangerous.

Three governance approaches assess internal leverage on system resilience: • **OM:** from 2020, the tidal outlet is dredged every 10-15 years to keep sedimentation at pre-1990s level (represents business-as-usual).

• **OB**: OM + fishing is banned in the tidal outlet, reducing efforts by 7% (outlet area relative to lagoon).

• **OL**: OB + alternative livelihoods- fishers exit the system at 1/1000/month.

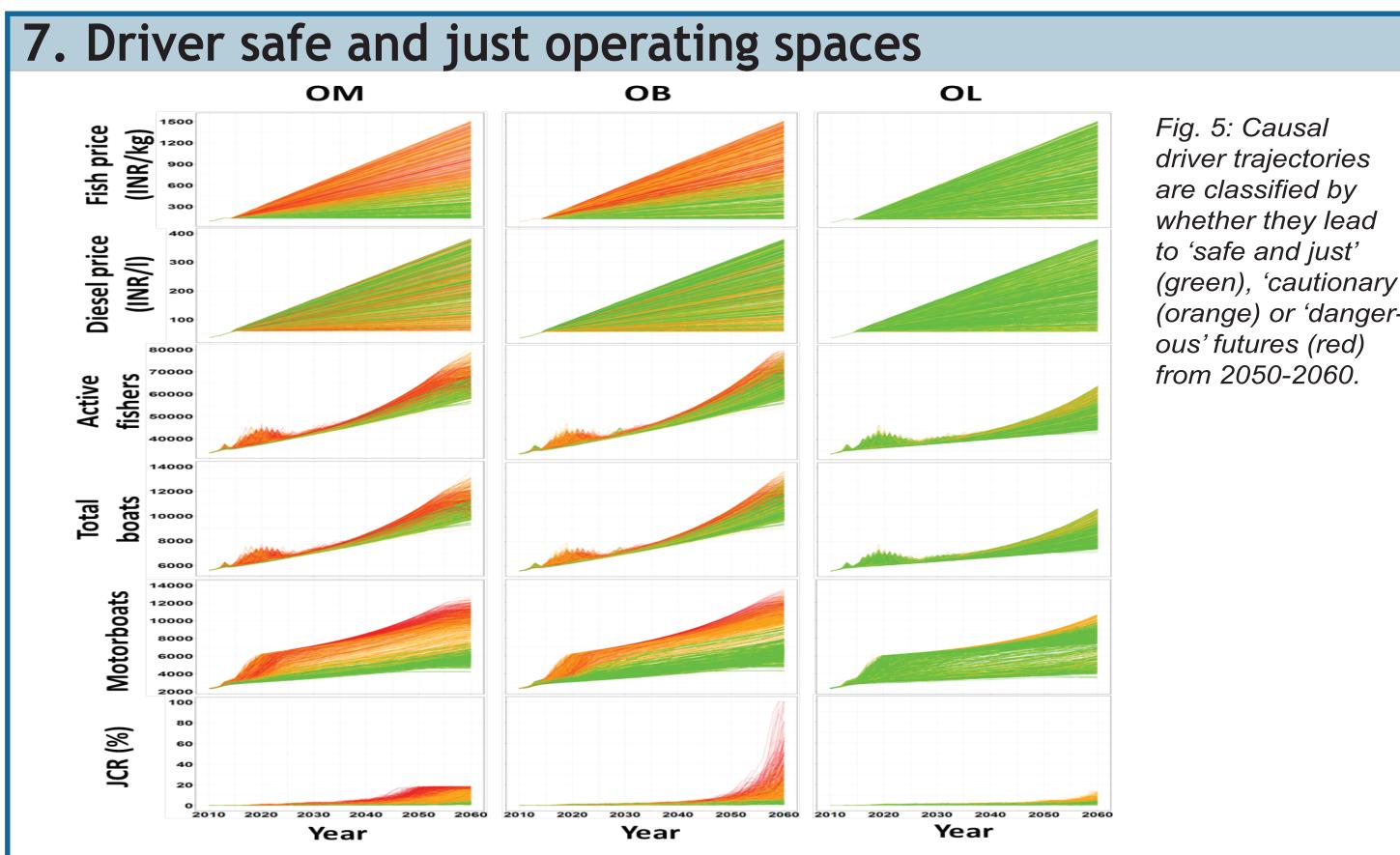
lisha's Integrated Coastal Zone Management Project (ICZMP) and Jadavpur University, Kolkata, for assistance and insights during the field visit of spring 2016

Geography and Environment, University of Southampton, UK

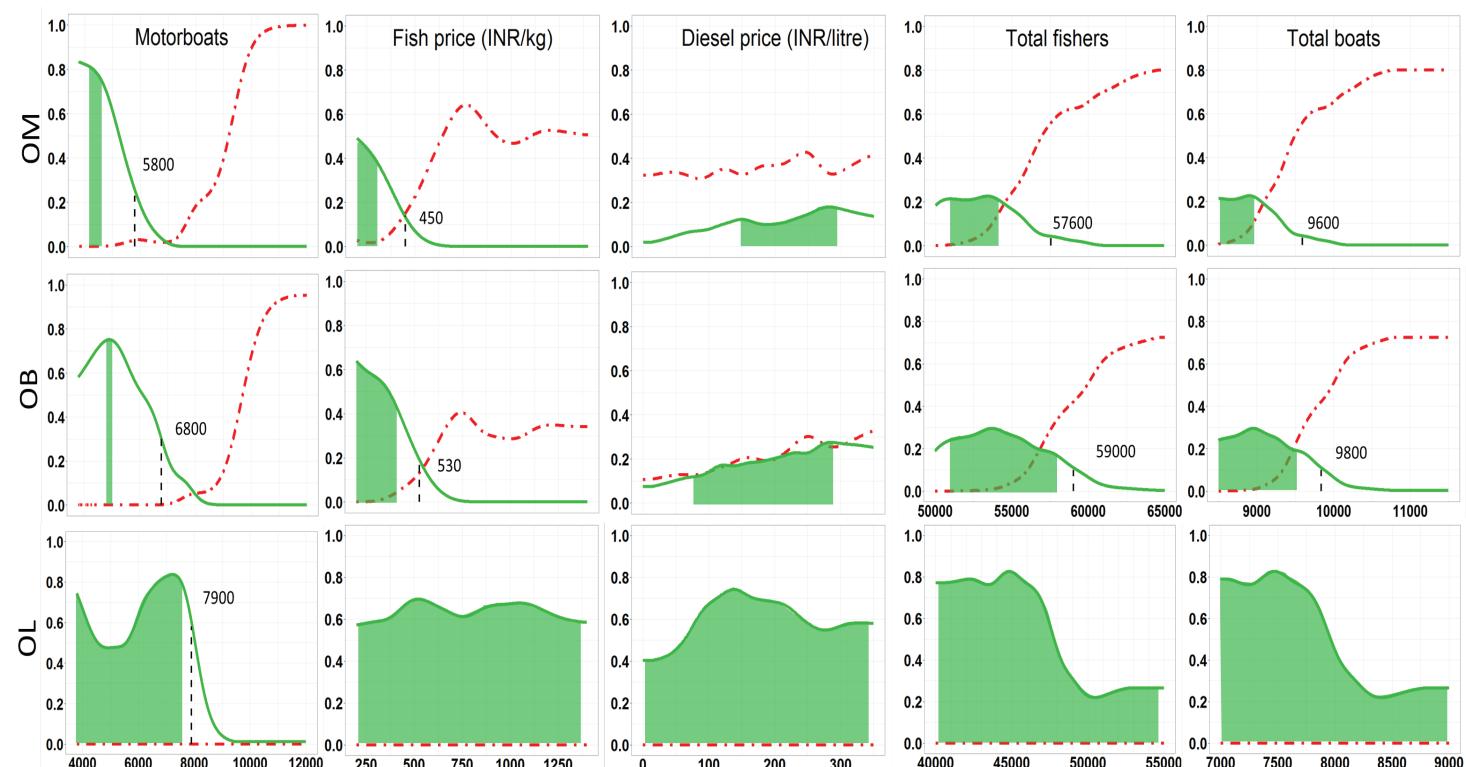
1. Research summary

• The 'safe and just operating spaces' (SJOS) concept is regionalised by the probability of a given driver trajectory producing sustainable catch from 2050-2060.

agsc1g11@soton.ac.uk



Rather than radar plots^{5,7,14}, conditional probabilities (Fig. 6) show the chances of a given driver trajectory producing each future. Each trajectory equals the max. value reached in the undesirable direction by 2050.



line) or 'dangerous' (red dashed) futures for given driver The core SJOS (green fill) shows trajectories that if simultaneously achieved give ≥75% chance of sustainaning MSY to 2060. Black dashed lines equal the 95th percentile of a given driver's SJOS. As of 2014: motorboats = 2300^{15} ; fish price = 141 INR/kg¹⁰; diesel price = 56 INR/litre; total fishers = 35,000¹⁰; total boats = 5,700¹⁰.

• Only socioeconomic drivers have SJOS edges . . . natural drivers excluded. • Core and wider SJOS tend to expand with regulatory governance, illustrating increased system resilience to internal and external stresses. • The number of motorboats can become unsafe across all governance scenarios . . resilience is linked more closely to fleet composition than size. • Core safety relies on narrow bands of motorboats; OL core occurs across all plausible trajectories of fish price, diesel price, total boats and fishers. However, tradeoffs may discourage transitioning from business-as-usual: (i) OB requires a shift from common property rights to greater command and control; (ii) Motorboats suggest improved human wellbeing but may cause overexploitation; (iii) OL catch from 2015-25 averages 3% less than OM.

• We present a forward-looking tool to guide the governance of regional systems along social-ecologically safe and just pathways.