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RESEARCH ARTICLE

Co-production and transformative change: lessons and challenges

Lyla Mehta, l.mehta@ids.ac.uk
Institute of Development Studies, UK and
Norwegian University of life Sciences, Norway

Nathan Oxley, n.oxley@ids.ac.uk
Institute of Development Studies, UK

Shibaji Bose, shibbose@gmail.com
Independent consultant

Mihir Bhatt, mihir@aidmi.org
All India Disaster Mitigation Institute, India

Nobuhito Ohte, nobu@i.kyoto-u.ac.jp
Kyoto University, Japan

Pankaj Joshi, pankaj@sahjeevan.org
Nature Foundation, India

Synne Movik, synne.movik@nmbu.no
Norwegian University of Life Sciences, Norway

Mahendra Banani, mahendra.bhanani@gmail.com
Nature Foundation, India

This article takes the case of the TAPESTRY project to look at how transformative change can be co-produced between local communities, researchers, community-based organisations and other actors. We lay out the process, challenges and tensions of doing co-produced research with marginalised people in marginalised environments affected by climate-related uncertainties and other crises. We reflect on the strategies needed to ensure that the voices of the most marginalised, who are at the forefront of climate uncertainty, are able to come to the fore and as far as possible in their own terms. We argue that despite significant challenges due to the COVID-19 pandemic and in tackling existing power relations and social and gender

inequities, co-produced research can help lift and give spaces to voices and perspectives that do not normally find their way to the realm of decision making. We demonstrate that critical transdisciplinary and interdisciplinary co-produced research can help reframe marginalised landscapes, and challenge dominant narratives and relations of power. While identifying concrete impacts on the ground can sometimes be difficult, co-production in itself can be a powerful agent of transformative change, leading to iterative learning and new insights among all participants. However, there are limits to how much can be achieved and scaled up in a conventional three- or four-year research project, calling for funders and donors to encourage longer-term engagements that enable local communities to take forward the research evidence and co-produced actions in locally appropriate ways.

Keywords transformation • transformative change from below • co-production • interdisciplinary and transdisciplinary research • South Asia • climate change • uncertainty • COVID-19 pandemic

Key messages

- Critical transdisciplinary and interdisciplinary co-produced research can help reframe marginalised landscapes, challenge dominant narratives and relations of power.
- Co production in itself can be a powerful agent of transformative change leading to iterative learning and new insights amongst all participants.
- There is a need to rethink conventional notions of impact in co-produced research.

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Introduction

Other articles in this Special Issue have focused on how co-production and transformation are understood and experienced 'from below' in diverse communities in marginal environments affected by climate change and related uncertainties. From vulnerable coastal areas in the mega-city of Mumbai to the deltaic Sundarbans, and the Kutch desert, we have seen how these disaster-prone coastal 'patches' are characterised by ecological uncertainty and also rapid socio-economic change (see also Mehta et al, 2019). Top-down interventions such as aggressive industrialisation, highly commercial real-estate development or fortress conservation, often in the name of 'development', have exacerbated the effects of climate change as well as inequality and vulnerability. An important element of such transformative efforts is not just proposing alternative livelihoods that can support locally led adaptation (see Cannon et al, 2025). More important is also the reframing of environments that can help make sense of complexities and uncertainties to push back against dominant framings and trajectories of unsustainability and, where possible, initiate alternative development, however small at this stage (see also Movik et al, 2025; Bose et al, 2025).

In this article, taking the case of TAPESTRY[1] project, we look at how such transformative change can be co-produced between local communities, researchers, community-based organisations, the state and other actors. We outline different

ways in which co-production can be understood and explored in the context of transformation from below. We also explore the politics and challenges of mapping impacts of plural pathways of transformation. Potential transformative pathways can be socio-ecological, economic, political, cultural or livelihood-related. As we demonstrate in this article, they can also be epistemological in that they reconfigure dominant ways to view nature–society relations by bringing to the fore invisible and marginalised perspectives. Some transformations collaborate with others while some collide, but all lead towards possible futures. We thus examine the dynamics of co-production, why it matters, and also whether it is possible to map trajectories and indicators of change that capture issues related to access to resources, environmental sustainability and local livelihoods. The article is structured as follows: we begin by engaging with conceptual debates on co-production and why it matters, followed by examples of interdisciplinary and transdisciplinary transformative action in TAPESTRY as well as different approaches to and outcomes of co-production. We turn to challenges in mapping impacts of transformative change and conclude with why process is as important, if not more important, than concrete impacts regarding transformative change.

Why co-production matters for transformation

Transformative change involving deep-seated structural change is only possible if plural pathways of knowledge-making are facilitated and encouraged, in order, among other things, to explore alternative livelihoods, as well as recognising and giving voice to often oppressed local knowledge systems. TAPESTRY focused on transformation as praxis where praxis is 'a reflexive process involving both a critique of the existing social arrangements/status quo and the search for alternatives' (Mehta et al, 2021: 112). Our focus was both interdisciplinary (bringing together academics from different disciplines) and transdisciplinary (bringing together academic and non-academic actors, especially practitioners). Through 'hybrid transformative alliances' of researchers, local communities and community-based organisations from India, the UK, Japan and Norway we worked together to create and study change from below. Post-normal approaches such as transdisciplinary research are increasingly the norm in studies on societal transitions and transformations (see Moser, 2016; Pereira et al, 2021; House et al, 2024). Our approach, however, sought to go beyond social innovations and niches in the context of sociotechnical transitions (compare Grin et al, 2010; Markard et al, 2012; Hargreaves et al, 2013) to explicitly focus on the strategies of the disempowered in marginal spaces who are part of hybrid alliances that are seeking to create transformative change from below. We see transdisciplinary co-production and learning as a key way to address complex societal and sustainability issues through knowledge exchanges and expertise across different societal actors (see Polk, 2014; 2015; Westberg and Polk, 2016). Following Jasanoff (2004), the emphasis is to bring about change and transdisciplinary co-production that stresses reorganisation of social structures and the interconnections across different scales, knowledge and practice.

This is why co-production played such an important role in our research. Co-production can be conceived of as a method that attends to and works against dominant inequalities (Bell and Pahl, 2017). The term has its origins in ideas around co-production of public services in town and regional planning (Ostrom, 1990; Jasanoff,

2004). Over time, co-production has come to serve as an umbrella term referring to processes of collaborative knowledge production in a diversity of contexts. We recognise that knowledge about environmental and climate change is co-produced alongside the social orders in which it is shaped and driven (compare Jasanoff, 2009). Hence, our notion of co-production is not just about bringing different groups of people together to create new knowledge (compare Ostrom, 1996). Instead, it is more about teasing out forms of knowledge that are often overlooked or undervalued by more conventional forms of knowledge-making, hence the epistemological potential (see Movik et al this volume). This includes embodied, emotional and tacit ways of knowing and representing the world, and 'hybrid' knowledge (see, for example, Benessia et al, 2012), requiring a pluralist sensitivity and appreciation for a persistent diversity of understandings (Stirling and Marshall, 2018). This responds to the complexity of climate change–related uncertainty, which calls for greater collaboration across disciplines and sectors and between a range of actors (state, academic, NGO and citizen) rather than working within the narrow parameters of particular sectoral or disciplinary boundaries and conventional organisational structures in local government, agencies and research institutions (Palmer and Walasek, 2016). Co-production thus allows for wide-ranging collaborative efforts to challenge expert-driven models of decision making towards ones that are more plural, just and inclusive (see Palmer and Walasek, 2016; also see Bremer and Meisch, 2017 for co-production in climate research and knowledge production).

Co-produced research usually aims to avoid accessing a pre-existing reality. Instead it is active in the creation of reality (Law, 2004) which is why the project sought not only to study and understand change but be a part of it. Co-production can situated 'within', 'against' and 'beyond' existing power configurations (Bell and Pahl, 2017). Thus, co-productive efforts require attention to shifting relations of power and domination. First, co-production from 'within' existing power configurations relates to research design and methods. Thus co-production should start with the design of the research itself including the aims and methods to be used, which will allow community members to frame problems and methods in ways that are seen as relevant and appropriate to their knowledges and lived experiences. Co-producing research questions may help to facilitate 'useful' and desired forms of knowledge. Second, co-production 'against' existing power configurations implies challenging the separation between researchers and local communities. This does not mean doing away with these divisions altogether, or assuming that hierarchy does not exist, but rather questioning and challenging implicit assumptions around collaboration, participation, equality and non-hierarchy. Third, co-production 'beyond' existing power relations seeks to push beyond present 'cramped spaces' and seek out alternative futures, where the potential inherent in co-production might be realised in ways we cannot yet imagine. TAPESTRY attempted to embrace all three approaches, with variable success, as we go on to outline, not least given the challenges of COVID-19 lockdowns and illness, as well as micro- and macro-level politics and structural constraints.

Overall, co-production is a 'risky method of social inquiry, as it is time-consuming, ethically complex, emotionally demanding, inherently unstable, vulnerable to external shocks, subject to competing demands and it challenges many disciplinary norms. This is what makes it so fresh and innovative' (Flinders et al, 2016: 261). In this article, we lay out the process, challenges and tensions of undertaking co-produced research. We also outline some of the strategies we deployed to ensure that the voices of the most

marginalised, who are at the forefront of climate uncertainty, were able to come to the fore and as far as possible on their own terms. We also reflect on the challenges of interdisciplinary and transdisciplinary work as well as different methodological choices and approaches and the wider ethics around these co-produced experiments. We argue that despite significant challenges due to the COVID-19 pandemic and in tackling existing power relations and social and gender inequities, co-produced research can help lift and give spaces to voices and perspectives that do not normally find their way to the realm of decision making. As we demonstrate, such an approach can help reframe marginalised landscapes, and challenge dominant narratives and relations of power. On top of concrete impacts on the ground, co-production in itself can be a powerful agent of transformative change leading to iterative learning and new insights among all participants. However, there are limits to how much can be achieved and scaled up in a conventional three-or four-year research project, calling for funders and donors to encourage longer-term partnerships and engagements as well as resources and funding left in the hands of local communities to take forward the findings and evidence in locally appropriate ways.

Co-producing change in a context of climate change, uncertainty and polycrises: approach, methods and patches

Our focus was on critical transdisciplinary and interdisciplinary research where the orientation was to go beyond the incremental (accepting and working with the status quo) to instead embrace the fundamental approach (working against the status quo and 'business as usual') in order to challenge current regimes and work towards alternatives seeking long-term transformation (see House et al, 2024; Fisher et al, 2022). Our normative position involved a kind of 'transgressive learning' that 'intentionally generates critical thinking and collective agency and praxis that directly and explicitly challenges those aspects of society that have become normalized' (Lotz-Sisitka et al, 2016). This means focusing specifically on issues of epistemic, environmental, social and gender injustices as well as domination and privilege upfront.

In TAPESTRY, we focused on how bottom-up transformation takes place in three 'patches' in India and Bangladesh: coastal Mumbai, dryland Kutch and the Sundarbans delta. These three 'patches' (compare Srivasta et al, 2025) are all in so-called 'marginal' environments facing high levels of uncertainty associated with floods, droughts and cyclones and the uneven impacts of capitalist expansion. TAPESTRY employed a suite of methods following an embedded approach spanning social science (ethnography, interviews, focus group discussions), natural science (GIS mapping) and arts and humanities (visual and creative methods and archival research). Across the patches, our research drew on the *longue durée* engagement of several team members building on past and long-standing research and practical commitments of different researchers and local partners. This allowed us to also understand multiple trajectories of changes over time in each of the patches. The methods were tailored to the communities' needs and capacities since they were active stakeholders in our research. Archival research in all the patches provided historically situated understandings of uncertainty as well as contrasts between official and local responses. This blended approach also led to *in situ* innovations such as participatory GIS mangrove mapping with herders (Kutch) or place-based ecological monitoring with fishers (Mumbai). The innovative visual (PhotoVoice, archival photography) and creative methodologies (paintings with school

children) helped lift hidden and marginalised perspectives. These helped to co-create visions of transformation from below, linking more secure pasts to sustainable futures. They also inculcated a sense of identity, dignity and agency to contest dominant state strategies that threaten further marginalisation and exclusion. Additionally, in each patch we had initial consultations as well as ideation and participatory workshops at different stages of the research (on which, more later). These, as well as internal project meetings, helped us to co-create our research ideas and plans. Later in the project, we used these spaces and the roundtables to get feedback on initial findings, from local stakeholders and communities, and together draw out conclusions. In this article, we focus specifically on the co-production that emerged through the interdisciplinary and transdisciplinary engagement – visual approaches as well as roundtables.

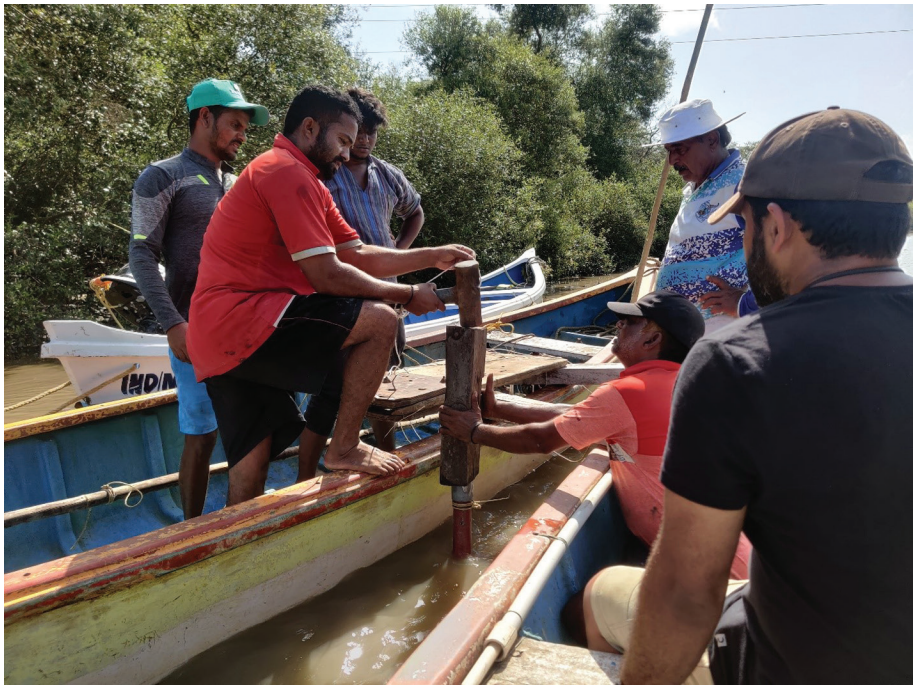
Across these patches, actors in hybrid alliances – local communities, NGOs, scientists and some state agencies – are seeking socially just and ecologically sound alternatives, based on local people's plural understandings of what transformation entails. The focus on praxis lent itself to action-oriented research that was guided by reflexivity, dialogue and negotiation (Mehta et al, 2021: 116) where we (the team) sought to facilitate an engaged process of situated learning, working with locally based partners who both research and co-produce transformative action with local communities.

For example, Koli fishers in Versova, Mumbai are challenging the growth-led paradigms of urban expansion, while also carving out ways to sustain artisanal fishing livelihoods in a context of climate change and urban waste – in particular, plastic pollution, which is damaging their fishing habitats. Researchers from TAPESTRY worked with Bombay 61, an urban planning and design think tank located in Versova Koliwada (a fishing village) to co-produce initiatives with local Kolis that address mangrove conservation (see Figure 1), as well as place-based mapping of the creek that aims to challenge the perception of the creeks as a drain or sewer in order to enable fishing in the creek and livelihood revival. One such experiment was a pilot

Figure 1: Final meeting of a series of ideation workshops with Kolis in Versova Koliwada, Mumbai

Credit: Bombay 61.

Figure 2: Fisherfolk led-researcher-civil society co-produced net filter initiative in the Versova creek



Credit: Bombay 61.

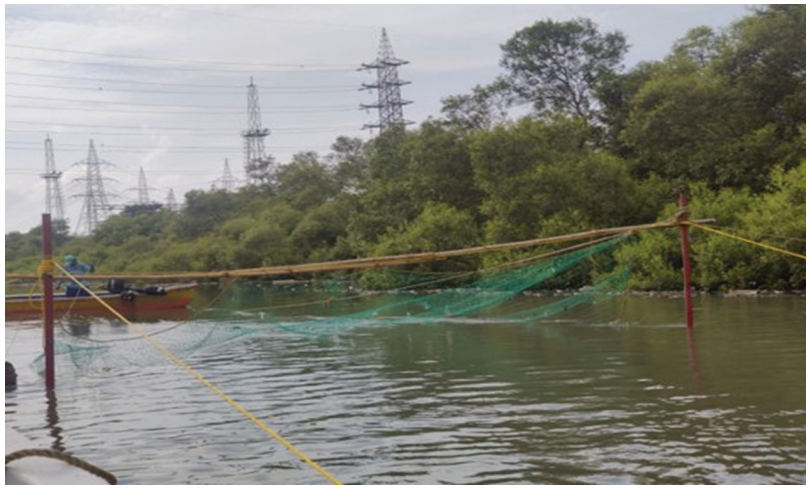
trial of net filters to collect waste from the creek (see Figures 2 and 3). This pilot built on the ideas and experiences of local Koli fishers and their Indigenous knowledge.

In the deltaic Sundarbans in India and Bangladesh, extreme weather events and climate volatility have undermined many islanders' well-being. TAPESTRY helped facilitate collaborative efforts between civil society organisations (namely, Caritas in both India and Bangladesh and its local partner Lokamata Rani Rashmoni Mission (LRRM), based in the Indian Sundarbans), local communities and scientists to restore ecology and livelihoods. The team then observed and studied initiatives around saline-resistant agriculture, fishing and water management. Roundtables on both sides of the India–Bangladesh border helped shape research methods, test initial findings, discuss alternatives and create the need for transboundary perspectives (see Figure 4, and section on roundtables).

In the drought-prone drylands of Kutch in Gujarat, TAPESTRY worked with villagers and civil society organisations focused on pastoralism, including Sahjeevan and Kachch Unt Cherak Maldhari Sangathan, the Kutch Camel Breeders Association (KUUMS), to challenge dominant state paradigms regarding drylands and pastoralism, while also studying ways to revive pastoralist livelihoods (through the sale of camel milk) and enhance biodiversity. The final roundtable focused on the co-produced methodological innovations (that is, bringing together GIS with Indigenous knowledge and practices) and successfully challenged the dominant narrative that blamed camels for overgrazing mangroves (see Figure 5).

Although such initiatives provided the scope to reimage nature–society relations in uncertain, marginal environments, they were resisted by incumbent players. There

Figure 3: Building on Kolis' traditional nets and knowledges, Bombay 61 co-produced net filters that were worked well and were effective. Kolis' embedded knowledge of setting up nets helped create robust net filter designs. The weave of the net is sparse at the beginning and becomes dense towards the rear end. This system successfully reduced at least 40 per cent of waste from entering the creek

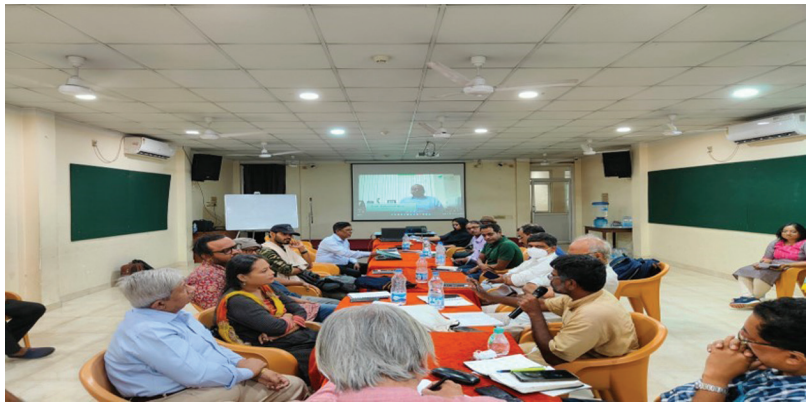


Credit: Shibaji Bose.

were also cases where they did not adequately challenge underlying inequalities associated with class, ethnicity, gender or caste. They also involved a delicate power relationship between researcher, civil society organisations and diverse communities. In every community, existing gender, caste and class divisions lead to local-level exclusions and unequal benefits from the initiatives. For example, in Versova Koliwada, there were differences and animosities between Indigenous Kolis and migrants from South India, and due to time and other constraints, most of the initiatives did not include the migrants. There was also relatively little enthusiasm for an initiative to focus solely on Koli women and home-based work for an independent income. In Kutch, due to gender hierarchies, most of the official activities mostly included the men, especially men with bigger cattle herds and larger land plots who led most of the process. And in the Sundarbans, the landless could not benefit from the interventions that focused on agricultural livelihoods, and women remained secondary in planning a joint future.

Often research co-produced with non-academic actors seeks not just to advance scientific knowledge, but also combines this knowledge with lay knowledge, and this is in itself a powerful agent of change (Moser, 2016). In a narrow sense, it is also about researchers and non-academic partners jointly developing a project whose questions and methods will meet their collective interests and needs (Durose et al, 2012). While this process can mostly be harmonious, at times there are also tensions. In Kutch, for example, the study sites were selected in a participatory workshop together with herders, and the criteria were developed by them. Our inception phase was intentionally quite long, and we also needed the time to navigate working across different rules and bureaucracies in four countries, and to deal with growing authoritarianism in India and its impacts on critical actors in the university and civil society.

Figure 4: Bangladesh-India Transboundary Sundarbans roundtable



Credit: Shibaji Bose.

Figure 5: A Jat pastoralist speaking at the policy roundtable in Kutch

Credit: Shibaji Bose.

Our project was also severely constrained due to the COVID-19 pandemic. Fieldwork was impossible in 2020 and only started in a physically distanced way at the end of 2021. During lockdown we had to resort to phone interviews, research using social media, and digital research alongside secondary research. Most of the work during the pandemic was possible because of partner institutions working on the ground, including in relief work in Mumbai and the Sundarbans. COVID-19 mitigations pushed our series of roundtables towards the end of the project. Many members of our consortium also suffered personal losses and bereavement, especially during the second deadly delta wave in India. The pandemic also intersected with extreme weather events (such as floods, heatwaves and cyclones). Mumbai and the Sundarbans experienced two cyclones each in the 2020–21 period. These 'compounded uncertainties' (see

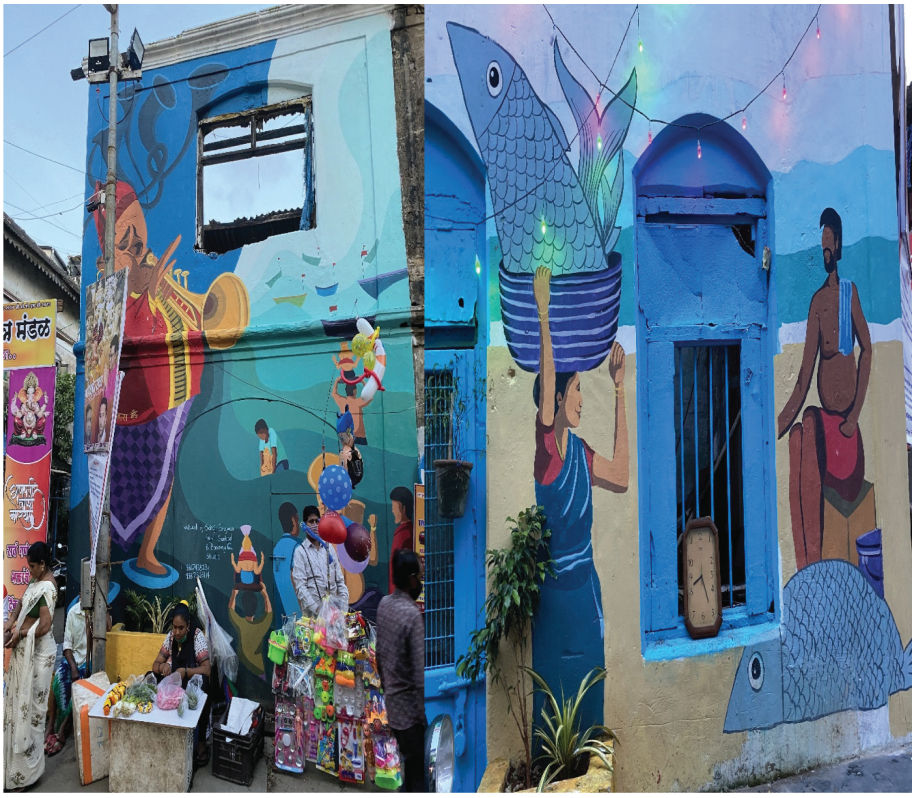
Pickard et al, 2020; Mehta et al, 2022) exacerbated the vulnerabilities of marginalised communities and existing inequalities linked to race, caste, gender, ethnicity, religion, income and information, which are themselves intensified by uneven geographies, uneven political economics, historical and sociocultural dynamics (compare Collard et al, 2018). COVID-19 also saw the roll-out of authoritarian and sectarian responses in India, along with neglect of informal workers (fishers, farmers and pastoralists, for example) and their livelihoods. Ongoing controversial neoliberal projects (including the Coastal Road in Mumbai) severely affected coastal ecosystems including wetlands and mangroves, and affected fishing grounds and livelihoods (see Pickard et al, 2020; Mehta et al, 2022). This wider context of polycrisis shaped the research context and constrained us in many ways, especially given the focus on transformative change from below. It also meant that we needed to adjust our plans and allow for 'care-full' research (compare Moser, 2024). Yet the disruptions to our research plans also enabled unanticipated solidarity, deepened relationships in the consortium and also led to new innovations in research.

What kind of co-production was enabled

In Mumbai, co-production was achieved from the 'within' and 'beyond' perspectives. The project was shaped by the concerns, needs and interests raised by community members themselves, based on their intimate knowledge of local creek and mangrove forests and their challenges. The co-production began with 'ideation workshops' with the Indigenous Koli community that generated perspectives of the community's knowledges, desires and demands regarding their fishing livelihoods, resources (such as creeks) and rights to the coast and city. These workshops also identified problems and suitable sites to implementing initiatives to meet their aspirations, hopes for their livelihoods and cultural heritage. Different options were suggested including ornamental fishing and ways to preserve the creek and address plastic pollution. After much deliberation and discussion, Bombay 61 and local women and men decided to roll out the net filter initiative. This built on local Indigenous knowledge of the creek and Indigenous techniques (the *Dhol* fishing net) to address plastic pollution in the creek. The net filter design not only effectively extracts plastic waste but also ensures the unimpeded movement of fish, safeguarding the livelihoods of Indigenous fishers. Bombay 61 and its partners see the involvement of young people in this work as crucial for the longevity and scalability of the initiative. The initiative also contributed to reframing dominant perspectives of creeks and *nallahs* as drains, to seeing them as life-sustaining water bodies, key for local fishing livelihoods and for coastal ecosystem resilience. Sites at Mandvi Gully and Bhandari Well, previously neglected and littered, have been transformed into vibrant multi-use community spaces, attracting vendors as well as local visitors and others. They also serve as gathering place for residents, particularly women.

The team also engaged with young Koli artists to create murals to enable place-making activities (see Figure 6). The project also drew on expertise and resources from Ministry of Mumbai's Magic, who also helped facilitate artistic expression and community engagement, especially in the place-making activities. All these activities helped created visions for future collaborations on urban renewal, as well as renewal of coastal ecosystems, which were also shared in the roundtables. Bombay 61's office

Figure 6: Mural on an old building celebrating 'our place, our identity and our traditional livelihood' – youth and artist led place-making initiative in Versova Koliwada, Mumbai



Credit: Lyla Mehta.

location in the Koliwada and the employment of Koli youth helped ground the initiative and sustain work during COVID-19 challenges.

The Bombay 61 team are urban planners and architects. Through the engagement with TAPESTRY, they gained a broadening of their understanding of urban justice, gender-just urban planning, livelihoods and access, as well as the importance of interdisciplinary approaches in addressing complex urban and coastal challenges. Urban planners also gained skills and insights in negotiation and dialogue. Yet, the project was unable to address conflicting interests and ownership disputes over public spaces as well as including all groups, for example migrants. In hindsight, earlier proactive engagement with the local authorities and policy makers would have helped to address regulatory challenges and secure long-term support for place-making initiatives. Fostering greater community ownership and leadership from the outset, beyond the few who contributed actively, would have helped sustainability and scalability of similar future projects. As in other patches, another challenge was to ensure the sustainability of the initiative, especially the net filter, after the end of our project funding. Thus, secure and long-term funding for a longer period of time is necessary to maintain momentum, a point we return to at the end of this article.

Sundarbans (India and Bangladesh)

Our work in the Sundarbans delta took a transboundary perspective given the cultural, ecological and other similarities across political boundaries. In both India and Bangladesh, we worked with informal alliances of community-based organisations, farmers, practitioners and researchers together with community groups of both women and men farmers and fishers. Community-based knowledge provided insights on various transformative initiatives undertaken after Cyclones Amphan and Yaas. Our ground-level partners facilitated interventions by providing seeds, money, training sessions and awareness activities, linking the community to the different government departments like agriculture, animal husbandry and fisheries. These initiatives helped the community recognise the potential of integrated farming and saline-tolerant species as sustainable livelihood options in the Sundarbans region.

At the very outset, the researchers together with the local partners, Caritas and LRRM (Indian Sundarbans), for example, organised inception workshops which brought together local government officials, NGOs and development organisations operating in the Sundarbans area. These workshops served as platforms to share our research plans and seek input from stakeholders, ensuring our work aligned with local needs and priorities. Meetings were organised in villages to understand community perspectives regarding the uncertainties affecting their fishing and agricultural livelihoods. Identifying climate-vulnerable communities in collaboration with local partners, we conducted extensive discussions through participant observation, focus group discussions and in-depth interviews to understand their challenges and explore potential solutions.

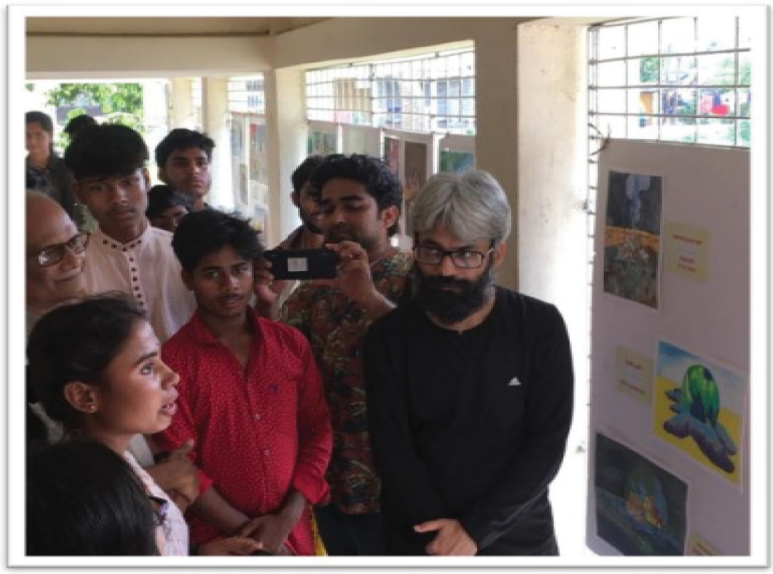
With our local partners, TAPESTRY collaborated in designing integrated farming approaches, adapted to include farmers with varying land sizes and those living in different village areas. Ground research from the community collected data and perceptions over the project period, tracking shifts in community dynamics and the initial impact. Through innovative co-produced methods such as digital diaries and PhotoVoice, we gathered perceptions from the eyes of the community and children along with their experiences and insights on climate change issues (see Figures 7 and 8). This participatory approach enabled individuals to articulate their thoughts freely, fostering deeper reflection on critical issues like weather variability, anthropogenic factors and state support through safety nets.

Perspectives and levels of awareness varied among the stakeholders. Logistical challenges, such as COVID-19 lockdowns and disruptions caused by Cyclone Amphan, hindered fieldwork activities, necessitating innovative data collection methods such as digital diary (Heron and Steckley, 2020) and PhotoVoice. Despite these challenges, the work brought together scientific agricultural techniques with Indigenous knowledge, increased participation and articulation of climate vulnerabilities and potential solutions, and collaborative initiatives leading to the co-design of integrated farming processes, fostering sustainable livelihood strategies. Participants in the research gained understanding of what did and did not work, including access to markets. In Sundarbans, work with farmers and partners spread awareness of salinity-tolerant rice varieties as a food security and livelihood response to climate uncertainties. Local partners facilitated transboundary learning exchanges between India and Bangladesh, sharing insights on research, policy and practice concerning community-led adaptation, animal husbandry, rainwater harvesting and maladaptation (such as crab farming). PhotoVoice groups presented to the West

Figure 7: PhotoVoice group engaged in discussing possibilities of co-produced transformative pathways amid uncertainties

Credit: LRRM.

Figure 8: Adolescent girl from Sundarbans narrating how she reimagines the future landscape through children's art



Credit: Anindita Saha.

Bengal government who expressed interest in sustaining the initiative on salinity-resistant seeds (see later). Our local partner piloted the 'Sundari Sundarban' (Beautiful Sundarbans) app to promote knowledge exchange between islanders, community-based organisations and policy makers. One of the major legacies is the transboundary dialogues which facilitate the vision of seeing the Sundarbans as a unified ecosystem as opposed to two countries.

We now turn to focus in depth on how co-production took place through interdisciplinary and transdisciplinary engagement in Kutch because it was here where we succeeded in bringing together community, natural and social science perspectives in ways that helped validate herders' perspectives and herders' knowledges and practices around mangroves and camels.

Co-production in Kutch through interdisciplinary and transdisciplinary engagement

One key element of co-production is interdisciplinary and transdisciplinary working. Transdisciplinary knowledge is critical to enable social and environmental sustainability and also challenge power and knowledge hierarchies and social orders (Moser, 2024). While most members of TAPESTRY are social scientists, our team also included natural scientists. Despite initial challenges, the team achieved an interdisciplinary and transdisciplinary way of working between both natural scientists and social scientists and also with community stakeholders. By taking the case of the relationship between Jat herders and Kutch's coastal mangrove ecosystem we outline how such co-production can result in transformative adaptation in the drylands.

India's western coast has the country's second largest concentration of mangroves, which are crucial in the livelihoods of coastal dwellers, including pastoralists. The coastal mangrove ecosystem is home to the unique *Kharai* (swimming camels), who swim from the mainland to mangrove islands (*bets*) to graze. The pastoralists have given names to each of the mangrove-covered islands, and they also sometimes cut mangrove leaves as major fodder. The Border Security Force and the forest department have imposed severe restrictions on access, and often deploy punitive measures to control the movement of herders and their animals. Based on advice of local partners, the team identified two villages on the coast and several surrounding *bets* for focused study. These were identified since pastoralists told us that they are the most important clusters containing grazing resources for the *Kharai*. The grazing areas fall under the categories of forest area, *gauchar* – grazing lands and government 'waste' land.

Since 2001, the coast of Kutch has been aggressively industrialised, which has led to massive depletion and pollution of coastal resources. Coastal commons have been reallocated from resource dependent groups (including pastoralists and fishers) to industries, turning the district into a corporate enclave (see Srivastava and Mehta, 2021). While there is substantial evidence on the rampant destruction of mangroves by industries and powerful corporate players (Kohli and Menon, 2016; Srivastava and Mehta, 2021), camel herders are often blamed. Scientists believe that camel saliva is harmful for the mangroves and that their trampling arrests the growth of seeds. But these claims are contested and have not been proven scientifically. They are disputed by pastoralists who argue that camels have lived and grazed in the mangrove forests for centuries, and happily coexisted with them. They also maintain that camels in fact help to regenerate mangroves, as their hooves press the seeds deep into the soil and help with germination – and also create 'micro-catchments' for new saplings to grow (Ohte et al, 2025).

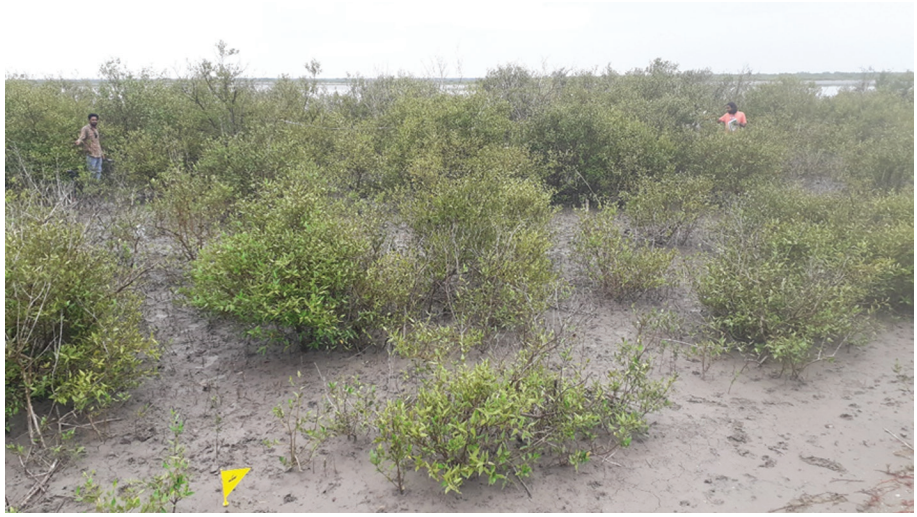
Despite shared interests, we discovered challenges in achieving mutual collaboration between social scientists and natural scientists. Questions and methods were very different between the social and natural scientists in our team, as was the time needed for surveys and the processing of data. Natural scientist Ohte did not have

prior experience of working with social science researchers or the local people and communities who were participants in the research. The team initially struggled to understand each other and felt that it was not easy for researchers from different disciplines to work together on a project. However, we persisted. Before the COVID-19 lockdown in March 2020, we were able to spend time together to learn about each other's methodology and approaches while visiting villages and the mangrove forests.

We began our research by identifying the target islands from the pastoralists' narratives. During this phase, Kutchi-based researchers explained that we hoped our planned survey would be beneficial for their future livelihoods. A participatory natural resource–mapping exercise bringing together natural scientists, social scientists, local NGOs and *Kharai* camel pastoralists helped us to understand the landscape and the geographical aspects of the mangrove islands and design the seasonal grazing routes protocols for sampling the mangroves. It was also useful to identify the potential mangroves/grazing areas for restoration to enhance ecological balances and sustain traditional pastoral livelihoods (see Figure 9).

While ethnographic data and participant observation focused on understanding narratives and experiences from pastoralists' perspectives, the natural scientists focused on gaining quantitative data through a long-term assessment of mangrove plant activity on each island, using data from satellite remote sensing. The time period was from 1988 to 2019. The data used in the analysis was the Landsat satellite images provided by NASA/USGS. The Normalized Difference Vegetation Index, an index calculated from satellite imagery data, can be used to express the increase or decrease in tree-canopy biomass. The results show that the biomass of the mangrove patches they were using as grazing land had been consistently increasing since the 1980s, even before the local government imposed restrictions on the islands after 2005. This showed that the use of mangrove-leaf biomass in their camel feeding did not

Figure 9: Pastoralists helped the researchers understand the landscape by sharing the seasonal grazing routes protocols for sampling the mangroves



Credit: Sahjeevan.

inhibit the growth of mangrove forests and lead to any kind of biodiversity decline. In fact in many places, camel–mangrove interactions led to biodiversity regeneration (Ohte et al, 2025). The data confirmed and validated the social science fieldwork and most importantly, the articulations of the pastoralists and local partners, and was able to challenge existing entrenched views on the negative effects of camel grazing on mangrove health.

In 2022, the results from the satellite imagery were presented to local pastoralists and district officials at a workshop. The pastoralists were delighted with the results, and they were also revealing for the officials from the forest department and others. Working in a transdisciplinary way was new for many of the researchers and local partners. For Joshi and Banani, co-authors of this article living and working in Kutch, this way of working highlighted several key components that they had not previously considered. These included considering young people's futures in pastoralism, intergenerational differences, and how interdisciplinary ways of working (including participatory mapping and remote-sensing work) can help validate local Indigenous perspectives of biodiversity and camel–mangrove relationships. A series of workshops and roundtables allowed representatives from the Camel Breeders' Association, pastoralist young people and women to share insights, photos and paintings made during the project and also express their aspirations to various government officials on livelihoods, culture and natural resources, including markets, entrepreneurship, young people's involvement in managing produce, and restoration or conservation of traditional grazing routes (see Figure 9). Bringing together social, technical and cultural knowledges helped challenge dominant narratives of camels as destructive of mangroves. Yet our work in Kutch was often limited due to tight restrictions on movement from border security forces, and a shifting of the priorities of one partner, along with staff changes, affecting the co-production efforts. We now turn to how we used creative and arts-based approaches to co-produce our research and transformative change.

Co-production via creative and arts-based approaches

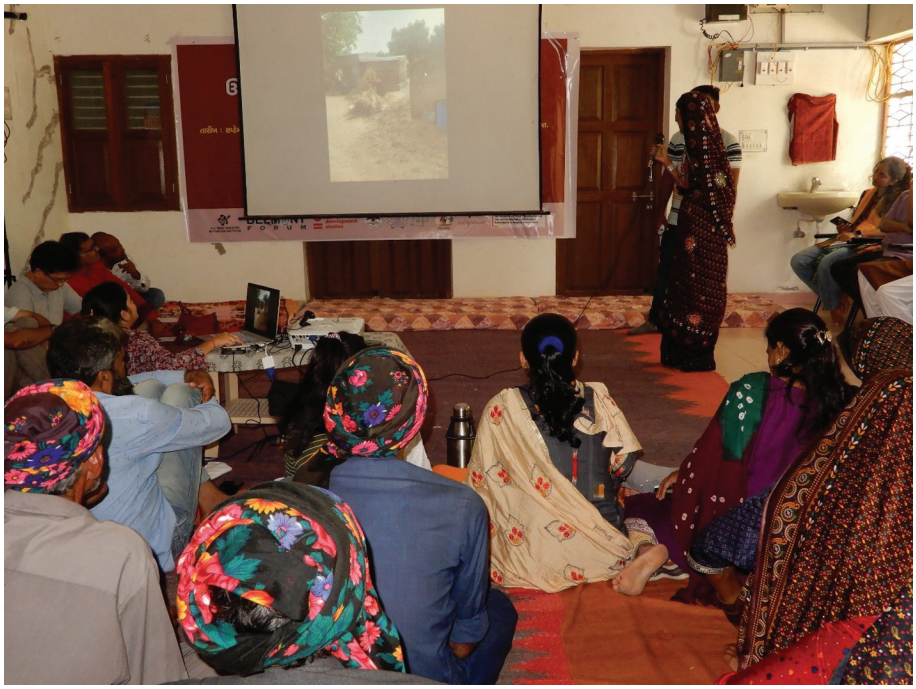
Visual methods used in TAPESTRY included PhotoVoice, photo-stories, digital storytelling and children's art to capture lived and tacit experiences of uncertainty and transformation. Such approaches aim to provide a voice to vulnerable and marginalised communities, making them active participants in research and the creation of knowledge (see Bose et al, 2022) rather than 'subjects'. Such co-produced research can potentially empower people to shape the conditions of their lives, creating spaces to produce and disseminate knowledge and actively shape development and research processes (Bose et al, 2022).

As discussed in Movik et al (2021) creative, participatory and art-based approaches can reveal hidden and alternative perspectives and solutions, while highlighting power imbalances that prevent alternatives ways of valuation and epistemic diversity, urgently required for transformative change. Creative and participatory methods can open up new and existing conversations that otherwise might be impeded by hierarchical social structures, such as caste traditions or gender inequities (Movik et al, 2021). These methods may include storytelling, mural paintings, PhotoVoice, photo-stories and others that seek to address power imbalances and ensure that hidden and subaltern perspectives are central. For example, we used a community-based participatory action

research method, PhotoVoice, to capture the embodied experiences of climate-related uncertainties and visions of transformation. Although scientists and policy makers may see climate change in the form of coastal erosion or warming temperatures, local people experience it in more tacit and affective ways. This manifests itself in loss of culture, place and identity, associated with threats to traditional pastoralist livelihood practices with a decline in camel numbers and changing access to traditional grazing lands on mangrove islands. Besides capturing these responses, the PhotoVoice methodology allows for silenced voices and perspectives to be communicated to different stakeholders. This is because visual images can break down language and disciplinary barriers which often impede communication and knowledge co-production (see Bose et al, 2025) (see Figure 10).

However, this was not without challenges and sustained engagement is required in building relations of trust and reciprocity as well as addressing power relations, including in the research process. In concrete terms this meant addressing the ethical challenges and the emotional pitfalls researchers faced before, during and after their field experience amid dual uncertainties – for example, the devastation of a cyclone alongside the lockdown induced by the COVID-19 pandemic in the Sundarbans. During lockdown, remote discussions were conducted with members of community-based organisations, schoolteachers, community leaders and partners in the field. They revealed numerous emotional and intellectual challenges arising out of work with vulnerable communities, due to issues such as migration amid the dual uncertainties of cyclones and the pandemic. Due to the pandemic restrictions, researchers were unable to go to the field and launch the PhotoVoice, which is a collective activity.

Figure 10: Women leading the community validation of research evidence



Credit: Shibaji Bose.

Instead, individual members from different intersections in the community maintained a digital diary (of pictures and narratives) of their perspectives from lived experiences, which they shared periodically with the researchers. The individual diaries were then discussed in groups and with other community members to ascertain whether the narratives and insights were shared by others in the individual knowledge is agreed upon by the neighbourhood and by the community. These discussions helped us build trust, empathy and respectful relationships with the participants when we resumed our research after the pandemic.

The co-produced storytelling between the Bangladesh and Indian Sundarbans brought to the fore communities' uncertainties during the pandemic and cyclones, such as inaccessibility during the storms and the closing of the island's border during the pandemic, which disrupted livelihoods and income for poor islanders (see Figure 11). These events protracted our fieldwork plans, but helped to instil some humility in the researchers and interlocutors by reminding them of the realities of fieldwork, power dynamics and the limitations of digitally less-literate people's voices in an internet-connected world. During COVID-19, communities we worked with took a long time to trust field researchers in an area already burdened with climate shocks. Still, the ongoing remote co-production through digital diaries was replete with transformative tales of solidarity and collaboration between the farmers and fishers during times of dual uncertainty.

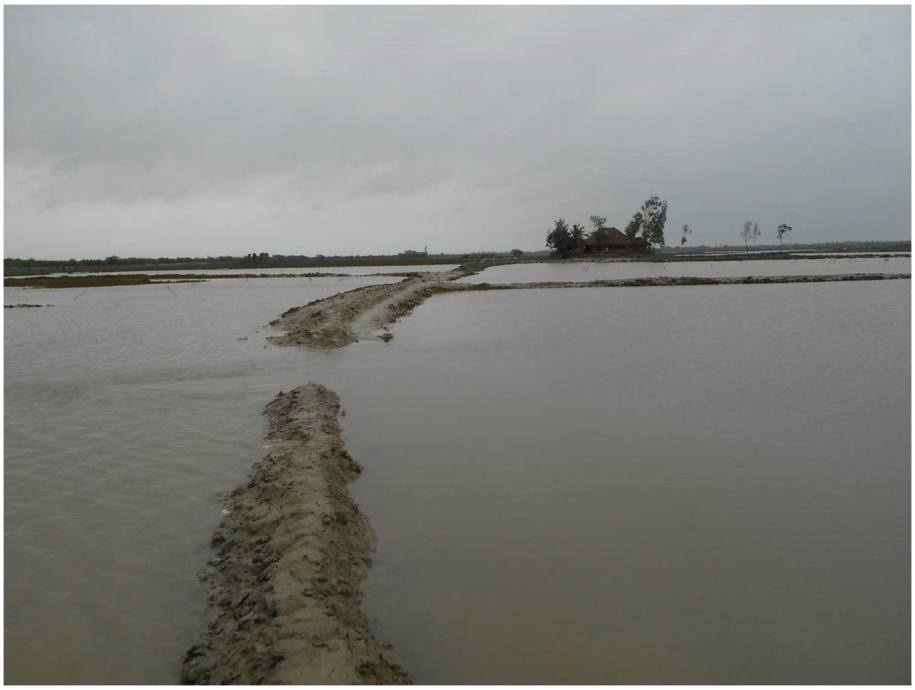
These embodied understandings can also facilitate dialogue with scientists and policy makers (see Figure 12). For instance, women from the Sundarbans used the PhotoVoice to make a representation of their demands to the Sundarbans Development Board in West Bengal (Ghosh et al, 2019). Women PhotoVoice groups also met the junior minister of the environment to speak about their problems and the measures that were taken in initiatives around agriculture and horticulture. Considering these efforts, the West Bengal Biodiversity Board, Government of West Bengal, entrusted the farmers to undertake *in situ* conservation and promote traditional Indigenous paddy varieties to minimise the impact of saline-water ingress, a slow-onset climate hazard.

Roundtables

Towards the end of the TAPESTRY, we organised five roundtables held in the patches, and a national one. In total some 200 stakeholders joined these sessions, two of which were in hybrid mode. Since our research was co-designed with non-academic partners, the roundtables aimed to break down disciplinary boundaries (Bhatt et al, 2018), refine questions, and test ideas and findings with wider actors working in policy, governance and research communities. Topics included policy options (for example, exploring risks to India's cities from climate change, and the possibilities of sustainable grazing in Kutch), wider justice issues (perspectives around loss and damage in Bangladesh), and research approaches and methodologies (possibilities of transboundary research in the Sundarbans and the implications of using visual methodologies).

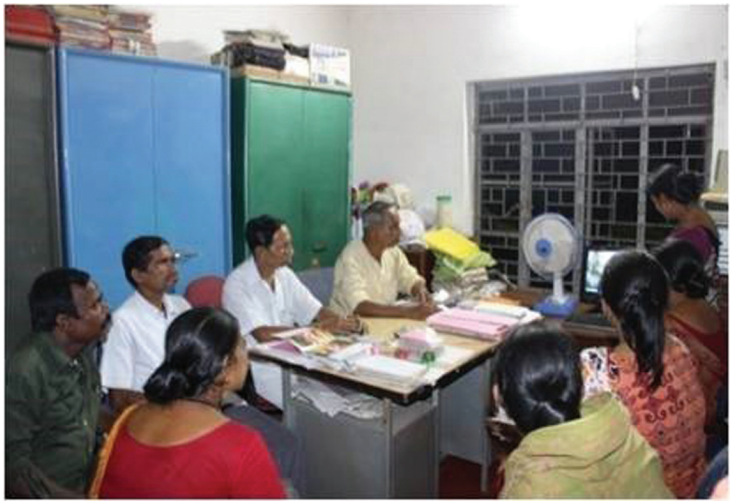
Roundtables stress 'the importance of bringing to the fore hidden, silent, marginalised, muted or alternative perspectives and solutions, while highlighting the need to address the power imbalances that prevent the application of alternative ways of valuation and epistemic diversity' (Mehta and Srivastava, 2020: 105), thus providing both challenges and opportunities for the co-production of knowledge. In roundtables, as in other forms of engaged research, knowledge is co-produced

Figure 11: The school and hospital access road flooded after Cyclone Yaas



Credit: Sundarbans women's PhotoVoice group.

Figure 12: PhotoVoice women group leaders presenting their narratives through the visuals to the *panchayat* (local self-government) representatives



Credit: Shibaji Bose.

through relations of power and their intersection with historical, social and economic processes (Mehta and Srivastava, 2020). While they present a potentially fruitful way of bringing divergent perspectives in dialogue with each other, these spaces can be politically charged (see Movik et al, 2021) but also offer a platform to discuss locally appropriate development and climate adaptation pathways for each patch.

For example, the Sundarbans roundtables allowed the delta communities from either side of the border to meet each other and see how their income and access to land, markets and livelihoods were comparable, what each is doing, and what can be done differently. The initiatives studied and undertaken in the different patches indicated alternative ways to strengthen livelihoods and reduce loss of livelihoods, and reduce direct economic and ecological losses to their incomes, assets and savings. On average participants estimated that it would take at least three to five years to see an impact on rise of income, accumulation of assets, or the use of new technology to emerge, and up to ten years to spread to new areas and communities and sectors in terms of access to markets, use of finance and organising into a sustainable business or a cooperative – well beyond TAPESTRY's funding timeline.

In the Mumbai roundtable, Koli youth and community members stated how useful the PhotoVoice and visual approaches were for recording experiences or views and sharing them more widely in Versova, Mumbai. They flagged that the approach could be used more in local day-to-day planning and for operation purposes such as solid-waste management, rainwater run-off planning and preparing-for-monsoon planning. Participants also underlined that for co-production of transformative change to take place effectively, everybody – from the community to academics or officials – should be treated fairly and equitably in the process. There were strong intergenerational disagreements in the fishing community with the youth often disagreeing with the visions of the older generation. Yet students and young people asserted that complaints, protest, arguments and dissent are integral parts of co-production of knowledge for transformation of areas such as the Versova Koliwada.

The roundtables also provided an opportunity for us to hear from participants what transformation meant to them. Different participants raised urgency, scale, social aspects or economic aspects as important. In the Indian and Bangladesh Sundarbans, many participants said that a rise in women's income and economic status is the best way to achieve transformation from current poverty to basic life with water, food, shelter, health, education and finance. Transformation is real when it is substantially engaged to affect lives, livelihoods, health and economics as well as environmental assets, simultaneously. Most roundtables also highlighted the need to scale up and out the small initiatives of the project to wider scale, such as to an entire district or several districts (Kutch roundtable). For example, the leaders of the camel owners were keen to have joint activities of milk production and distribution with other villages that were appropriate and relevant to their domestic income and needs. The animal husbandry department officials of the state government were more keen to have economic activities within the various existing welfare schemes be more effective and timely in terms of within the budget timeline. In the Sundarbans, participants wanted more frequent communication and interactions within the delta and also across national boundaries. The need for more cross-sectoral cooperation, for example across fishery, forestry, animal husbandry, and other coastal and rural sectors, was a common articulation in all the roundtables. Many participants, including the late

Professor Saleemul Huq, also stated the importance of state and national governments taking an interest in and investing in such initiatives, allowing for experiments and local pilots to take place. In many cases, issues raised in the roundtables went beyond the scope of a three-year project, something we return to in the conclusion.

Challenges with demonstrating impact

Research projects, including TAPESTRY, are often required in proposals to identify pathways to impact and how they will be used effectively. As outcomes could not be predicted in advance, our proposal acknowledged that impacts would vary by location and emerge 'through complex processes of negotiation, co-production and resistance'. In this section we discuss relationships between notions of 'impact' and transformation, and how these notions informed the project over time.

Critiques of the 'impact agenda' have pointed to the complexity of incentives shaped by state funding agencies (Martin, 2011) and a potential 'disciplining effect' on research (Ely and Oxley, 2014). Internationally, there are significant variations in how impact is conceived and assessed; and in research in disciplines such as history and human geography, impact can take a long time to emerge (Brauer et al, 2025), beyond the timescale of a three-year research project. Transdisciplinary research poses a challenge to evaluation in that it is 'unique, emergent and non-discrete', and attribution may be a matter of perception (Kny et al, 2023: 182). Predicting and planning outcomes at proposal stage risks excluding non-academic partners from engaging with the aims and scope of the project (Lawrence et al, 2022). Hence TAPESTRY adopted an adaptive, flexible approach that would respond to the emerging needs of our collaborators, and acknowledged that we were intervening in processes with longer histories and potential futures.

The focus of the project was on supporting people and groups who are marginalised and made vulnerable in part by bureaucratic, techno-centric, top-down responses to uncertainties and disasters. 'Transformative' alliances and adaptations emerged as important in addressing root causes and challenging incumbent development approaches. Transformation also requires reframing development problems, questioning what is considered 'normal' and whose perspectives count. This meant highlighting multiple visions and viewpoints, including through participatory visual, art-based methods and place-making (see Figure 6). We aimed to contribute to transformative change, reflect on processes of co-production, and critically examine transformations and what they mean to different people.

The wider Transformations to Sustainability (T2S) programme we were part of asked its investments to draft a Monitoring, Evaluation and Learning Plan (see Mukute et al, 2024: 21) to frame its activities during the project. This required us to identify 'indicators' to use. The set of indicators we identified were:

1. Identifying gaps: gaps in knowledge, practice and policy identified.
2. Stronger alliances: alliances between civil society organisations/community/others strengthened to participate in decision making at policy level.
3. Co-production of knowledge: knowledge produced is collaborative, and reflects sharing and feedback.
4. Potential for material benefits: signs of potential or actual benefits to livelihoods of local marginalised people or reduced pollution.

The time and resources available for tracking and evaluating impact were limited. This tracking and documentation was mainly carried out via internal meetings and discussions, as well as by regular reports and lists of activities submitted to the project's funders. We had began by using an internal survey, and then added to this with feedback at online project meetings and deeper reflections at in-person workshops.

At the end of our funding period, we reflected on the dynamic between 'impact' and 'transformation' at our closing internal workshop in July 2022. Our thinking broadened from selecting 'impact indicators' (starting from the standpoint of our own planned activities) to asking: what kinds of transformations had we observed during the past three years, how had we responded, and what had our responses meant for those transformations? This meant attending to changes in alliances, knowledge and material differences being shared and generated from below, along with wider constraining or enabling material and political conditions – for example, the COVID-19 pandemic, historic inequalities and marginalisation, and incumbent commercial and political interests.

For instance, we were able to observe governmental responses to the COVID-19 pandemic and extreme weather events in real time, and how people in our study sites were affected and acted; it was clear that the conditions for this were shaped by pre-existing notions of authority and control, failures of preparedness and chronic inequalities (Mehta et al, 2022). These events were inextricable from the central questions on compounded uncertainties being asked by TAPESTRY, and therefore the research programme adapted to respond to them.

As discussed earlier in this article, the COVID-19 pandemic and restrictions on movement had a significant impact on the logistics of the project and the questions that were investigated. Site visits, planned initiatives and action research were impossible for almost a year, and international travel was severely restricted. The research team adapted to the situation by holding meetings, stakeholder workshops and interviews online, and carrying out PhotoVoice discussions via the internet. Even after the lockdown was lifted, there were problems in obtaining permission to access some sites. Furthermore, devastation from cyclones, migration induced by various disasters, and the halting of much economic activity and social mobilisation prevented community-based organisations and communities from carrying out their normal activities.

In our final workshop in July 2022 we reflected on areas for transformation and identified a series of areas to consider where change was being co-produced:

Equitable access to resources – changes in systems and rules for governing and administering resources/rights or access to resources.

Ecological sustainability – changes in the health of natural vegetation and quality of water, or measures to deal with pollution, soil degradation or unsustainable land use.

Empowerment – improved representation of the interests of marginalised groups in decision making, or challenges to patriarchal norms and unequal gender relations.

Visions – changes in visions and framings in policy and planning, or spaces for plural visions to be discussed between different stakeholders.

Co-production, innovation and livelihoods – broader options for livelihoods/improvements in livelihoods.

Examples included:

Equitable access to resources: in Kutch the forest department and the Border Security Force became aware of our work and to an extent about the rights-based issues of grazing and mobility. They were also sensitised about these issues and 'realised' that this 'must be important' because researchers are working on it. The pastoralists are slowly beginning to negotiate their access to natural resources with Border Security Force and forest officials with the help of local groups Sahjeevan and KUUMS.
Ecological sustainability/co-production: use of net filters adapted from traditional technologies in Mumbai's Versova waterways, leading to reduced plastic pollution.
Ecological sustainability: the court orders helped to protect the mangroves in Maharashtra, and helped enhance the livelihoods of fisher folk. The state government was also forced to protect mangroves and take action against violators.
Empowerment: creation of the 'Sundari Sundarban' (Beautiful Sundarbans) app allowing islanders to share concerns more immediately with policy makers.
Visions: coastal communities around Mumbai actively participated in the preparation of the Coastal Zone Management Plans.
Visions: seeing the Sundarbans not through two different nation states but as a single continuous ecosystem.
Empowerment: TAPESTRY provided training to develop new artistic skills that would help to earn livelihoods in near future.
Empowerment: Students in the Sundarbans are eager to preserve their Indigenous knowledge for the posterity, and also suggested to incorporate their traditional knowledge and skills as an optional subject at higher school level.
Co-production, innovation and livelihoods: community people (in Bangladesh Sundarbans) are cultivating fish, vegetable and paddy in the same place, utilising integrated farming processes.
Scaling up or out: scaling up the livelihood concerns of the Kolis to larger environmental concerns of the city that can be addressed in Mumbai Climate Action Plan.

Other examples of co-production discussed earlier in this article add to this picture. These include the reframing of creeks in Mumbai from sewers to life-giving waterways and community spaces; farmers' active roles in conservation in the Sundarbans; and scientific validation for camel grazing of mangroves in Kutch, with the active participation of pastoralists themselves in shaping and carrying out the research. These examples suggest a variety of ways to feed into transformation: experimenting with techniques, creating new visions or ways of seeing, building channels to communicate ideas, and sensitising policy makers to the needs of those who have largely been ignored. These approaches confront a complex set of challenges that make transformation uneven and unpredictable, including: maladaptation to disasters; incumbency of interests and dominant framings in development trajectories; imbalances of power; the potential for conflict at many levels; the persistence of social hierarchies and prejudices; and unexpected shocks. They also suggest a rich set of processes for enabling co-production in response to uncertainties: shaping questions with input from people living in 'marginal' spaces; using storytelling and other artistic

methods to reveal neglected perspectives and questions; experiments and pilots that can be reversed or adapted; taking account of uncertainty, dissensus and conflicting views; creating platforms for dialogue between different interests; acknowledging the role of advocacy, dissent and protest. Relations, capacities and struggles are as important as particular techniques or technologies. This richer set of approaches and struggles encourages us to look far beyond linear stories of research impact where knowledge creation is led by experts and packaged as definitive evidence to inform policy makers or practitioners to help them more effectively meet sustainability goals.

Discussion and conclusions

This article discussed challenges and potential around co-production in transdisciplinary and interdisciplinary efforts to study and create transformative change from below in contexts of climate uncertainties in South Asia. Our work took place against a range of uncertainties and crises (from extreme climatic events to COVID-19) and we engaged with some of the most marginalised groups in marginal environments. Despite the acute suffering during the pandemic, we found that local communities, activists and their allies are actively finding ways to deal with and adapt to a range of changing circumstances and also working on different possibilities for reimagining transformative pathways towards just and sustainable futures (Mehta et al, 2022).

Working closely with local actors and alliances of researchers, NGOs and local people, TAPESTRY sought to study and be part of these changes and processes, and experimented with alternative livelihood and transformative approaches from below, largely drawing on insights and practices from the margins. Due to the nature of TAPESTRY and funding cycles, some of them could not continue; yet some have been continued in different forms (the Sundarbans app, for instance). In all the patches, we sought to study and, in some cases, challenge the current and dominant status quo that has intensified unequal and unsustainable development processes on the coast. We also co-produced bottom-up processes that challenged negative framings of coastal landscapes in the drylands, wetlands and urban fringe that denigrate the lives and livelihoods of local coastal dwellers such as fishers, pastoralists and farmers. This took place through the interdisciplinary and transdisciplinary engagement between both the social sciences and natural sciences, complemented by PhotoVoice and visual approaches. We found that co-production is not a single or linear process (Moser, 2024) and that co-production of climate knowledge requires altering the modernist and homogenising frame of knowledge production and dissemination that has for long colonised practices through target-oriented top-down framings (Mehta and Srivastava, 2020). This means embracing more decentralised and plural ways of knowing with an aim to co-produce both new knowledges and social orders. We have also outlined the challenges in such processes in tackling existing power relations and social and gender inequities and in dealing with changing realities on the ground (for example, COVID-19 and changes in priorities of local partners). All this makes it important to develop methodologies and practices that open up new forms of dialogues among a diversity of actors and knowledges (see also Massarella et al, 2021). These must both challenge existing social orders and embrace the multiple modalities of future-making and plural practices of anticipation and living with uncertainty. Thus, co-production calls for active engagement and participation in all stages of the TAPESTRY project, including ideation, design, planning, resource

allocation, strategy, operation, monitoring and evaluation. We believe our emphasis on co-production and its engaged processes substantially increased the number of communities and stakeholders reached, facilitated cooperation and collaboration, and led to actions that were more locally appropriate, effective and timely.

The previous section discussed the challenges of achieving more conventional kinds of 'impact' that funders often seek. Often transformative interventions are those in which 'knowing' and 'doing' are undertaken 'as more distributed and relational than commonly represented in heroic narratives of control' (Stirling, 2014). Our experiences suggest that in groups and alliances gathered around particular interests or locations, learning unfolds over many years and decades, and knowledge and action are generated together through practices, skills, reflections and experiences. In these settings research methods need to articulate sensitively with existing knowledge and experience. Much important knowledge about ecologies is embodied and contextual in places.

Due to these wider contexts and specific realities of settings, we thus need to shift focus to longer timescales than typical windows of project funding: past histories and longer futures in which institutions and groups of people take forward their learning in ongoing struggles. The work of creating interactive spaces, using art-based methods and inviting new ideas or framings is bound to generate unpredictable outcomes, with new relations and capacities developed along the way. But such relations and capacities are vital in uncertain settings – where risks cannot be adequately known, there is disagreement around how to define problems, and surprises (from cyclones to pandemics) are common (Scoones, 2024). In all patches, we see the importance of local people taking care of the ecologies of which they are part, as well as monitoring and adapting in response to change. These activities challenge simple notions of 'scalable' replicable solutions to ecological uncertainty, but provide valuable lessons on methodologies, alliance-building and ongoing learning that might be applied or adapted in other settings.

As acknowledged by a review of the T2S programme, radical transformation of the status quo is difficult in a three-year project. This is why Mukute et al (2024) call for programme design for transformations to have greater funding, flexibility and a longer time frame, beyond just a mostly Northern-led three-year research programme. Genuine bottom-up co-production always tends to be a slow process and the necessarily slow pace of building mutual and trusting relationships is foundational for co-production. While we have outlined the challenges in every patch of sustaining some of the interesting experiments after the funding stopped, what TAPESTRY succeeded in doing was getting local actors and wider alliances (such as scientists and NGOs) to reframe landscapes, challenge dominant narratives and relations of power. We also succeeded in showing how local alliances can come together to successfully challenge 'taken-for-granted values, assumptions, power structures and approaches to social ordering imposed by those in positions of dominance' (Moser, 2024: 21). Our focus on co-production helped lift and give space to voices and perspectives (for example, from Koli fishers, Jat camel herders and poor islanders) that do not normally find their way to the realm of decision making. With these we succeeded in reframing mainstream notions of nature and society relations (around camel/mangrove relations in Kutch, for instance) to help open up, politicise and pluralise debates about nature-based solutions, biodiversity and conservation in coastal South Asia. In this way, the critical transdisciplinarity and interdisciplinarity outlined in this article allowed us to bring together diverse disciplinary lenses and practices across

scales and domains in order to uncover and challenge dominant power hierarchies, injustices and complex linkages between social, political, economic and environment change and how they affect the most vulnerable.

Our experiences with co-production reveal that process is as important, if not more important, than concrete impacts regarding transformative change. TAPESTRY's focus on co-design and co-production was in itself an agent of transformative change that allowed for iterative learning and the incorporation of new insights and perspectives among all participants in the research. We hope our lessons will highlight to funders and donors that longer-term partnerships beyond the project period are needed to maximise co-production benefits. There is also an urgent need for resources and funding to be left in the hands of community representatives to take forward the research evidence and projects to scale.

Note

[1] TAPESTRY is an acronym for the project Transformation as Praxis: Exploring Socially Just and Transdisciplinary Pathways to Sustainability in Marginal Environments (see https://tapestry-project.org). The project is financially supported by the Belmont Forum and NORFACE Joint Research Programme on Transformations to Sustainability, which is co-funded by ESRC, ISC, JST, RCN and the European Commission through Horizon 2020 under grant agreement No. 730211. The authors are grateful to numerous people in the patches who generously gave us their time to share their knowledge and experiences despite so many challenges during the COVID-19 pandemic. We are also grateful to the funders for their support. We thank Sarah Bird, Managing Editor, for patiently supporting us through the process and Emma Louise Meistad Hattrem for her support with the references and formatting. The usual disclaimers apply.

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Conflict of interest

The authors declare that there is no conflict of interest.

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