Cognitive Blindspot: Challenges of Measuring Coupling Effects of Isolated Development Policies at the Regional Scale

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1. Introduction: Challenges of Measuring the Spatial Impacts of a Policy

With a newly built highway near their village, Karan and Arjun decided to return to their rural roots in early 2000. On the one hand, Arjun, a garment merchant in Delhi, bought land abutting the proposed highway close to his father's place, a plot he knew well from his childhood days of playing cricket. On it, he built an almost replica of his three-storey Delhi house for his three-member household using the combined capital gained from selling ancestral farmland and borrowing from a bank. He later added temporary shops in the front on the government land left for road expansion, which he rents out. On the other hand, Karan, a construction labourer in Kolkata, permanently returned home as local construction demand like Arjun's sprouted along the newly minted highway. He and his brother sold their small ancestral residential land to a wealthy neighbour and moved to the periphery of the settlement, closer to the rice fields, where they could afford to buy a plot each. As individual households, each brother received a total of INR 120,000 as a loan via a government housing program. This federal assistance came in three instalments. Meanwhile, Karan locally borrowed an additional INR 330,000, taking almost a decade to complete his one-bedroom–veranda house for his four-member household.

Though overjoyed with home ownership, discomfort persisted in both households. For Arjun's, overheating from the concrete roof led them to build additional floors they did not need. Moreover, as open land rapidly became occupied by similar construction projects, Arjun's son frequently complained about the lack of a playing field in the village. For Karan's family, the difficulties were dire. The plot he bought remained unconnected to the village network. The muddy pathway they used often flooded, even with a light shower. The decade-long construction project left the exposed walls to gather moss and mildew with each rain. The money further borrowed for these repairs added to the considerable debt the household had already racked up.

The above accounts are composite characterisations of the income groups surveyed in 2019 in the Bengal region of India. These demonstrate the growing

plurality in rural lives with introductions to national roads and housing loans afforded by ongoing national policies to improve regional connectivity and household shelter. Such narrowly defined policy impacts limit their reporting, which is positively skewed to capture only the number of settlements connected or houses built, overlooking their broader, far-reaching implications, as illustrated here.

The primary hurdle for improving impact assessments is policy silos, whose distinct knowledge domains and organisational cultures further reinforce their separateness (OECD 2010; Addie and Keil 2015). Once implemented, however, such policies concurrently exist alongside other policies executed in the region, where the impacts of one policy can neither be standalone nor isolated from the effects of other policies implemented. Instead, their impacts combine, influence or catalyse each other to produce correlated transformations, often manifesting at multiple scales, referred to in this article as 'coupling effects'. While most assessments generally state the possible coupling effects of the policy, they measure its success using narrowly defined indicators in line with the work of the bureaucratic silo implementing the policy, thereby positively skewing their reporting.

Adding to this conundrum is the measurement of policy impacts in multiple jurisdictions with varying technical and financial capacities. Here, rapidly transforming areas like urban peripheries, small towns and rural settlements are particularly vulnerable to the pressures of coupled effects of regional policies. With limited financial resources and technical expertise allotted to these jurisdictions, local agencies here find it difficult to manage the transformations triggered—like rapid construction, an increase in land-use conversion, a rising demand for basic infrastructure, an increase in settlement size and a reduction in the built-environment quality (Denis and Zérah 2017; Cairns 2018). As a result, an ad hoc approach is used to manage these overlooked outcomes when and where they become critical or necessary, further splintering the benefits brought on by the policies (Kanai and Schindler 2018).

As policy impacts trickle to other nearby settlements, a domino of coupled effects unfolds, creating a vexing bureaucratic question—who should respond to these far-reaching implications of policy development? When they remain neglected, such transformations eventually snowball into regional challenges. This outcome is not unique to India. See, for example, Harvey and Knox's (2015) research on diverging processes and outcomes in Peruvian road development; Beck et al.'s (2017) collection of impacts in the making of African roads; Dalakoglou and Harvey's (2012) cross-border Balkan infrastructure experience; Donaldson's (2009) comparative research on the consequences of implementing different strategies in similar Chinese

provinces; and Kaufmann's (2016) seminal work on individual motility in six cities in western Europe, which studies the potential of mobility in a place conditioned by its social and geographical capacities.

Similarly to policy silos, the framework of the SDGs measures success through standalone indicators; this creates two consecutive issues for accounting policy impact at a global scale. First, the standalone metric system of the framework allows countries to have flexibility but also enables selective, positively skewed national accounting. In their reporting, countries can choose indicators that represent the positive impacts of their policies but exclude adverse effects caused by them, thereby underreporting correlated measures that are relevant but remain unconsidered (Guin 2016). Second, policies that enable material flows between different scales need assessments beyond their implemented jurisdictions. Moreover, with material flows structured globally, a city's or community's sustainability depends on factors beyond its jurisdiction (Brenner and Schmid 2015). However, while SDG 11 indicators logically summarise these broader implications of regional policies, their framework does not necessarily correlate them.

Such multiplicities make assessing regional sustainability harder yet imperative (Loewe 2012). Notably, a significant part of the world's population is transitioning from one lifestyle to another due to a rural–urban shift, climate change, resource depletion, economic slowdowns or political instability, amongst others factors, which requires a closer assessment in order to navigate towards a sustainable future.

In this chapter, using the regional data collected on road and housing development in Bengal, I show the susceptibility of assessing sustainable goals based on standalone indicators, as described above (Section 1). I first examine the challenges of measuring the coupling effects of national *road* and *housing* development policies introduced by India, which arise from their frameworks, implementation and reporting (Section 2). Then, I assess their coupling effects in rapidly transforming rural areas of Bengal (Sections 3 and 4), describing how the skewed selection of indicators by the Indian state largely ignores the varied impacts of these national policies on different income groups in the region (Section 5). In particular, I study the spatial impacts of these two policies using the wide array of indicators under SDG 11. Using this case, I show how the single lens of SDG 11 can present two very different policy assessments—one positively skewed as reported by the Indian state, and the other as ground realities, as demonstrated in Section 6. Here, I recommend points where the current indicator-based framework of SGD 11 can be improved to capture the varying, broad and far-reaching impacts of regional policies (Section 7).

2. Background: Road and Housing Development in National Policy

As a developing nation, India has set development targets to boost its economic development, reduce poverty and alleviate the standard of living. Road and housing have become key targets within the national development policy to achieve these objectives. I considered two development policies—(1) National Roads and (2) Housing for all—to understand how skewed reporting and assessments of such spatial policies have led to emerging planning challenges in rural India. In this section, I elaborate on the framework, implementation and reporting mechanism used in these policies, specifically how such selective reporting fulfils India's commitment to SDG 11.

2.1. Policy Framework

The Indian government considers roads "an infrastructure that provides access to social and economic services. They are an entry point for poverty alleviation and act as facilitators to create an agricultural surplus, improve basic health, provide access to schools and employment opportunities." (ILO-PMGSY 2015, v). Hence, increasing the reachability of households to roads is central to its planning.

Under national road development policy, multiple schemes at varying scales have been rolled out since the 1990s (see the highway system presented in Figure 1). They are based on the 'networked city' ideal (Monstadt and Schramm 2017). Under this ideal, the same infrastructural capacity (width and lengths of roads) connects similar-sized settlements, creating a hierarchy of roads per settlement size and population density in the region. In the 1980s, this growth-centric model was introduced in India to plan its 'urban turn'. The planning shifted from the four megacities, Kolkata, Delhi, Mumbai and Chennai, to other possible growth centres in each region (Kundu 1989). However, it was not until the 1990s that the government actualised this planning shift. After the economic liberalisation in the early 1990s, the golden quadrilateral project was launched under the national infrastructure development policy by the Ministry of Road Transport and Highways, MoRTH (Ghani et al. 2016). The large-scale road infrastructure projects connected the four megacities, stringing together the regional growth centres along the way. Subsequently, state governments funded the upgrading or construction of regional infrastructure (state highways and district roads) to increase the economic reachability of national highways.

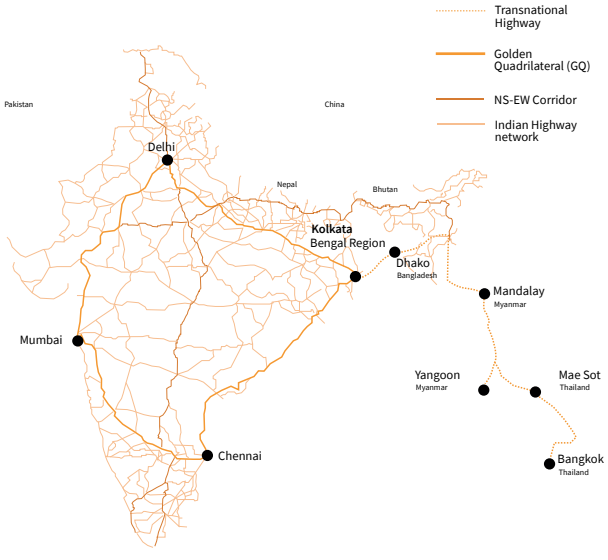

Figure 1. The Indian highway system confluences in the Bengal region. Source: Author's compilation based on data from Open Street Map.

The next wave of national infrastructure development policy came in the early 2000s. Under the public–private partnership with the World Bank and the Asian Development Bank, the Government of India and regional state governments proposed Pradhan Mantri Gram Sadak Yojana (PMGSY) to develop rural arterial roads (ILO-PMGSY 2015; ADB 2003). Under this ongoing scheme, internal district roads connecting villages of 500 to 1000 people to major roads were resurfaced or constructed, further increasing regional accessibility. Alongside, under the National Rural Employment Guarantee Act (NREGA) of 2005, rural governance agencies were provided with funds to locally employ and develop internal village routes, connecting settlements with a population of fewer than 500 people.

The collective system of infrastructure development under the national road development policy has improved local and regional accessibility to goods and services, with rural areas quickly transforming into urban-like developments and activities. Even the last census of India in 2011 reported rural regions to have

contributed 29.5% of India's urban growth in the last decade, with many rural settlements being statistically classified as census towns (CT)[1] (Guin and Das 2015).

Adding to this trend of rural transformation is the Housing for all policy, locally known as Pradhan Mantri Awaas Yojana-Gramin (PMAY-G). It was re-configured and launched nationwide in 2015 by the Ministry of Rural Development, MoRD (MoRD 2020; NITI Aayog 2017). Under this scheme, a rural household is offered a small loan at a low-interest rate from a formal financial institution if they own the land and live in a dilapidated house. Currently, households are loaned a total of INR 120,000 in three instalments. This amount is justified by the collaborated project carried out under the United Nations' Development Programme, Indian Institute of Technology—Delhi and Ministry of Rural Development, Government of India. The project "helps promote affordable housing for the rural poor. The first component of this has been to provide beneficiary households with a wider range of choices in terms of housing designs, materials and construction technologies. These choices are tailored to local conditions, aim to enhance user benefits and reduce the environmental footprint of housing" (UNDP 2020). This project proposes a hybrid version of the traditional mud and thatch construction for the Bengal region. Ironically, these traditional materials are also the basis of the criteria used by the state to select the dilapidated houses for this scheme in the first place.

2.2. Policy Implementation

In India, road and housing policies are centrally planned and locally implemented by public-sector companies, local administrative units and governance agencies. The multi-scalar organisation of agencies creates an implementation and reporting loop between the central, state, district and local governments.

In the national *road* development policy, national highways are developed and maintained by the National Highway Authority of India (NHAI) under the Ministry of Road Transport and Highways. The state-level Public Works Department (PWD) similarly tends to the state highways and district roads. Rural arterial roads under PMGSY are implemented jointly by the National Rural Infrastructure Development Agency, Ministry of Rural Development (MoRD) and state-level Department of Panchayats and Rural Development (PRD). On the other hand, locally elected rural governance agencies (Gram Panchayat), under the financial supervision of the Block

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[1] A rural territory is classified as CT if its settlement size exceeds 5000 persons, its population density is above 400 persons per km and 75% of its male population is working in non-agricultural sector.

Development Office (BDO) and state-level PRD, improve or develop the shorter village routes funded by the NREGA scheme.

In Housing for all, beneficiaries are selected based on whom faired lower on the national socio-economic survey. As per this survey and recommendations made by local rural governance agencies, each block office generates a beneficiary list. The funds are then channelled from the central agency to the state, to the district and then to the block-level (BDO) government office, the lowest administrative scale in this structure. The BDO transfers the funds directly to the selected households' bank accounts in three instalments, each after a construction phase has been locally verified. Currently, the verification is carried out visually and geographically (location-based photographic evidence) by an independent evaluator hired by the BDO.

2.3. Policy Reporting

The multiple agencies managing and governing at different spatial scales report back on the various schemes through policy-specific Online Management, Monitoring, and Accounting Systems (OMMAS), which accumulate the data gathered to showcase each scheme's success publicly. Data independently collected on these digital platforms displays the number of settlements connected, road lengths developed, and the number of beneficiary households and houses constructed. However, images collected during the monitoring process of these schemes show a high variance in the qualities achieved. Moreover, it is difficult to infer from the data provided if every household in the settlement has convenient access to the road constructed or the quality of the shelter built (Mukhopadhyay et al. 2016; Patel 2016).

Based on the quantitative data reported by various policies, NITI Aayog, the national planning and strategy arm of the government of India, announced the implementation of new indexing and dashboard methods that aspire to replicate the SDGs "to provide an aggregate assessment of the performance of all Indian States and UTs [Union Territories], and to help leaders and change makers evaluate their performance on social, economic and environmental parameters" (NITI Aayog 2019). However, the reporting is selective, with only a few indicators chosen per goal. Besides connectivity and shelter, other correlated indicators of SDG 11—(a) the adequacy and safety of the houses, (b) access to public transport, (c) sustainable speed of urbanisation (settlement size), (d) access to basic infrastructure, (e) air quality, (f) access to open spaces, and (g) policies and strategies—that can address the urbanisation challenges of today (United Nations 2019) are ignored in the goal's assessment. The skewed positive reporting of these policies hinders timely actions in

mitigating the correlated adverse effects of these policies on the communities (Guin 2016), undercutting their aims by themselves.

3. Methodology: On a Road in Bengal

Roads' and houses' prevalence in society makes the policies developing them susceptible to coupling effects.[2] As ordinary and ubiquitous artefacts, they embody material, services and financial flows and influence their channelling into and through a region (Harvey and Knox 2015). Besides households' accessibility to roads, the quality of these artefacts determines households' reachability to other amenities and opportunities in the region. Still, the insular manner in which roads' and houses' impacts are assessed ignores the far-reaching and varying consequences of these developments (Lawhon et al. 2017)—a failure that leaves the most vulnerable entrenched.

Thus, I consider the regional transformation of Bengal triggered by national road and housing policies to demonstrate the gap between selective SDG 11 indicators reported by the Indian government and the adverse coupling effects of these policies as observed on the ground. In particular, I present two coupling effects from the survey data collected. First, how does the relationship between road development and housing construction affect the size of settlements, irrespective of whether these settlements are adjacent to the roads developed? Second, what type of planning and governance issues do these constructions create in rural areas that leave the most vulnerable entrenched?

This study follows the methodological framework of cartographic collage and in situ fieldwork developed by Cairns and Chen (2019) in selecting the case. The cartographic college is an assemblage of large datasets illustrating regional trends. I used population density, agricultural production, road development and the urban–rural jurisdiction category to select case sites.

3.1. Case: Bengal Region

Bengal's transformation has become a prominent example for new urban theories on subaltern knowledge, which examine rapidly transforming territories beyond the city to understand development trends that frame a region's transformation (Mukhopadhyay et al. 2020; Brenner and Schmid 2015; Cairns 2018).

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[2] For examples, see anthropological case studies on roads from around the world (Windle 2002; Mrázek 2002; Khan 2006; Campbell 2012; Ciabarri 2017; Diener and Batjav 2019).

The recent growth of new Census Towns reported by the last national census (2011) is central to such studies in India. While Census Towns are statistically considered urban, they still fall under the rural governance system, regionally called Panchayati Raj, which is composed of locally elected officials. The resources and expertise allocated to such rapidly transforming territories are equal to those allocated to any other rural jurisdiction in the region. Among Indian states, Bengal has the highest number of new Census Towns, with 537 (Samanta 2012). Moreover, the Bengal region is at the confluence of Indian infrastructure developments (discussed in Section 2.1, Figure 1), as it contains the megacity of Kolkata and borders with other ASEAN economies. It also has a large, predominantly young rural population. Such numerous attributions make the Bengal region critical to this study.

3.2. Case Sites: Bagnan and Simlapal

Two sites, Bagnan and Simlapal in the Bengal region, were selected to be surveyed and to conduct interviews. They are very geographically different (see Figure 2). On the one hand, Bagnan is an extended arm of the Kolkata metropolitan area, being 60 km away, accessible by rail and road. The commute takes about two hours using either type of infrastructure. The site selected in Bagnan contains five CTs and twelve villages. Households in this site are predominantly independent of agriculture-related activities as their source of income. On the other hand, Simlapal is an emerging in situ urban centre. The closest urban influence comes from Bankura city, a district town about 45 km away, accessible only by road, and takes one and a half hours by bus. It takes five to eight hours to reach Kolkata from Simlapal. The site selected in Simlapal contains a standalone CT and nineteen villages. Households in this site have mixed-income sources, with agriculture contributing significantly to it. The two sites are on either end of the spectrum of the rural transformation story unfolding in Bengal.

3.3. Data Collection

In 2019, 197 households from the two sites in Bagnan and Simlapal were surveyed and interviewed in total. The data capture the changing patterns in construction typology, location, land use, plot condition and services available between 1990 and 2019. As the data collected contained sensitive household information, I was advised by NGOs and researchers familiar with the local context to approach households through networks familiar to them. Hence, with prior permission from the district magistrate, block development officer and head panchayat officer in each site, I requested local neighbourhood representatives or

community volunteers to aid the introduction process. Additionally, for approval by the university ethics committee to conduct this study (EK 2018-N-114, approved on 13 February 2019), consent forms contained clauses on anonymity, which prohibits individual representations of participants in the analysis or description of this chapter.

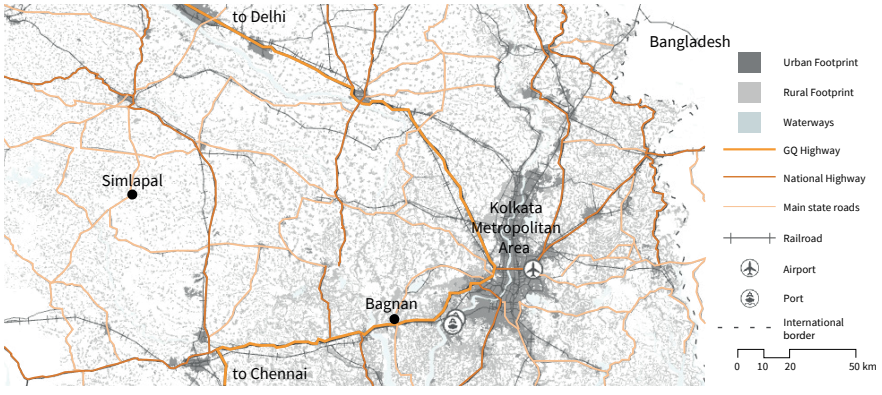


Figure 2. Bagnan and Simlapal's location in the Bengal region. Source: Author's compilation based on data from basemap—ESRI, HERE, Gramin, FAO, METI/NASA, USGS; Road and Rail—Open Street Map, Airport, Port, Border and Footprint (2015–16)—Bhuvan WMS.

During the data-gathering process, I employed a typological approach to capture the varying housing practices of different economic groups (see Figure 3). Each surveyed household was selected as per its housing typology and immediate-access typologies. A substantial distance (100 to 200m) between the surveyed households was maintained to represent the two sites' varying road and housing conditions. Figure 4a–f includes example images from the fieldwork for each housing typology mentioned in Figure 3. The colour coding represents the spectrum of contemporary (tints of orange) to traditional (tints of blue) materials used by surveyed households. The analyses in the following section use the same colour coding distribution to understand the variability in impacts felt between different income groups, represented by the materiality of their house tabulated in Figure 3.

	M	Multistory Brick and mortar (> 2 floors)					
	P Brick & Mortar	PK1 Old concrete technology	PK2 Brick and Mud	PK3 Old wood technology	K1 Tin or Asbestos with mud	K2 Tiled or thatch with mud	K3 Makeshift shelter
Roof	Reinforced concrete slab	Reinforcement concrete slab using river stones chips	Reinforced slab with broken brick bats as fillers	Composite mud slab supported bywooden rafters	Tin or Asbestos	Terracotta tiled or thatch	Plastic sheets
Wall	Brick and cement	Stone and cement	Brick and mud	Brick, and lime and ash	Tin	Composite of Mud and thatch or Mud and Mud and Bamboo	Bamboo or jute plant
Plaster	Cement	Plastered only inside with cement		Lime and ash		Mud	
				PK4	Composite weathered concrete structure		
				PK5	Composite weathered mud structure		

Figure 3. Housing typology legend. Source: Author's compilation based on survey data collected in 2019.

The following sections use the colour coding and typology abbreviations given in the table above.

4. Analysis: Movements and Segregation in Transforming Settlements

By tracing where and how people build their houses, I demonstrate the coupled effects of implemented national *road* and *housing* policies (Kaufmann 2016; Harvey and Knox 2015). Housing practices illustrate the type of land, construction materials, labour, and technical experts available to households in a region. When these flows change, they show the influence of new or upgraded accessibility. Through the variance in housing typologies, we can also see how different socio-economic groups were differently impacted by the two policies. This section shows how the coupled effects of the two policies individually impacted the region's performance on the various indicators of SGD11 using the data gathered in Bengal.

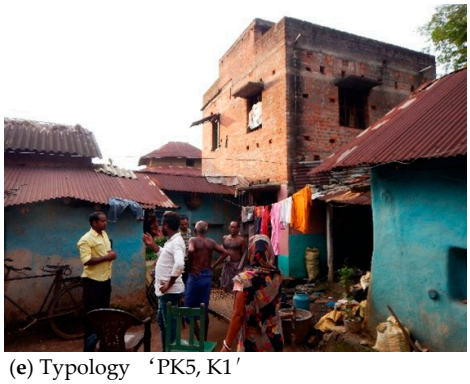
1. Movement: plots where people build their houses between 1990 to 2019 to observe changes in settlement size and built-environment density.
2. Differentiation: plots' quality and cost of the houses built to observe inter-group variations.
3. Technical repercussions: plots' on-site difficulties described post construction to observe rising planning and governance issues in the region.

(**a**) Typology 'M'

(**b**) Typology 'P'

(**c**) Typology 'PK1, PK2, PK3'

(**d**) Typology 'PK4'



(**e**) Typology 'PK5, K1'

(**f**) Typology 'K2'

Figure 4. Housing typologies: (**a**) multi-storey (M); (**b**) contemporary brick and mortar construction (P); (**c**) old construction typology (PK1, PK2, PK3); (**d**) incremental, composite structure (PK4); (**e**) composite weathered construction of brick, mud, and tin (PK5, K1); (**f**) mud and tile construction (K2). Source: Photos by author, 2019 fieldwork in Bengal region.

In Section 5, I discuss these individual plots together to explain how the coupled effects of these two policies originated, unfolded and connected the transformations observed here.

4.1. Movement

Construction practices in India also shifted with the economic reforms in the early 1990s. The change in materials also reflects the changes in flows within the region. The combination of locational choices and housing typology illustrates the kinds of movements developed by groups of different incomes. Figure 5 shows the transition from traditional to contemporary forms of construction over time. A clear shift in the materiality of the new construction projects from mud-and-thatch houses (K1, K2) to brick-and-mortar houses (P) can be observed. Additionally, composite house type 'PK4' has increased as economically weaker households imitate more popular brick-and-mortar constructions. These shifts raise the question—where are these newer houses being constructed in the settlement?

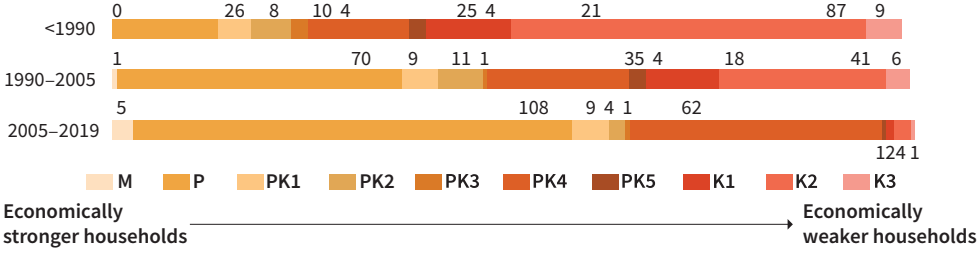


Figure 5. Distribution of housing typology per historical snapshots. The typology of the household has been determined by the construction material used, representing the household's spending power. Source: Author's compilation based on survey data collected in 2019.

The shift in households' motility (Kaufmann 2016), brought on by new or improved road infrastructure, is referred to as the 'movement'. Motility, the relative position of a household in an infrastructural network, represents its affordability and needs in a region. In rural areas, a household demonstrates its motility by choosing where to build its house in a settlement. The three historical snapshots below illustrate the changing motility of Bengal's rural households between 1990 and 2019 (see Figure 6a–c). Each snapshot spans the implementation cycle of the different road and housing schemes considered (see Section 2). Per frame, the households' distance from the nearest major road (highways and district roads) and their relative

locations within the settlements are plotted and distributed according to their housing typology. Together, they highlight the effect of these shifts on settlement size and built-environment density.

The three snapshots considered are as follows:

(a) Pre-1990, prior to the national road development policy being implemented.
(b) From 1990 to 2005, when the golden quadrilateral project was implemented connecting Kolkata to Delhi and Chennai, and state and district roads were also improved by the West Bengal government.
(c) From 2005 to 2019, which includes the roll out of the two rural road schemes—PMGSY and NREGA. Concurrently, the expansion of national housing development policy to rural areas.

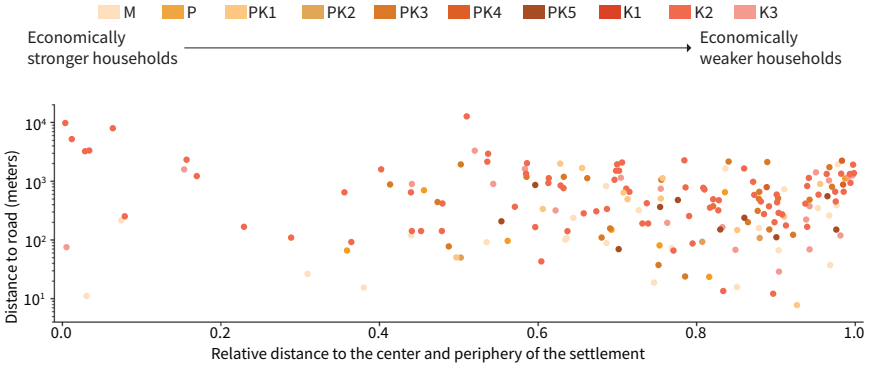
The graphs below (Figure 6a–c) show the following:

- Densification of old settlements between 1990 and 2005;
- A rapid increase in settlement sizes as houses move to the periphery or available open spaces between 2005 and 2019;
- Rise in difference between the types of location available to different economic groups;
- A decrease in residential land use at the centres;
- A shift of economically weaker households (PK4 to K3) to the periphery of the settlement.

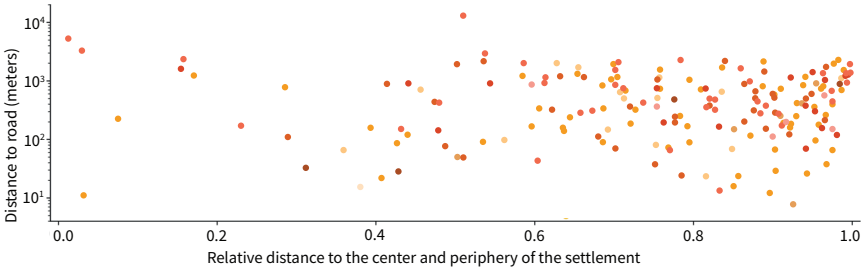
By 2019, it could be observed that housing typologies have shifted towards the contemporary construction style under the new housing policy framework implemented between 2005 and 2019 (see Section 2.2 for details). As a result, the settlement size has rapidly increased, while inequalities have risen between households. The economically weaker households (PK4) are squeezed out, away from the road towards locations with inconvenient access to public transport. Compared to 1990, a clear segregation in the housing typology can be observed in 2019, with the most common being between 'P' and 'PK4'.

4.2. Differentiation

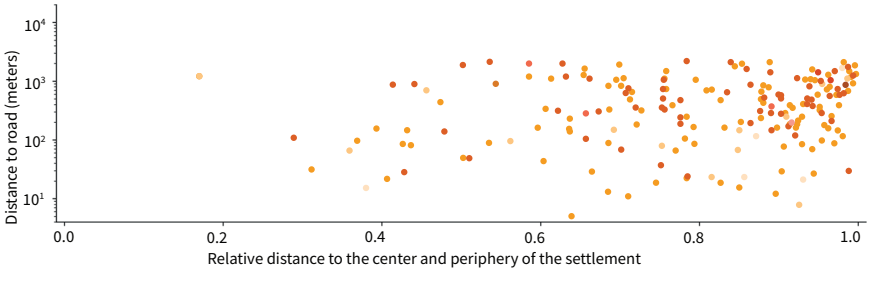
The spatial outcome of the two 'movements' (discussed above) in housing practices is referred to as 'differentiation'. This second coupled effect addresses the housing quality achieved by groups in different economic circumstances. The plot below (Figure 7) correlates the area built per household member with the construction cost per square foot. This distribution highlights many erroneous assumptions made in the framework of rural housing policy.



(**a**) Location and typology of the households before 1990.



(**b**) Location and typology of the households between 1990 and 2005.



(**c**) Location and typology of the households between 2005 and 2019.

Figure 6. The x-axis represents the relative location of the household in relation to the village centre. The 0.0 on the x-axis represents the village centre, whereas 1.0 represents the (2019) periphery of the settlement. The y-axis represents the distance of the household from major roads. The y-axis has a logarithmic scale due to the high variation in the distances from major roads. The typology of the household has been determined as tabulated in Figure 3. The relative locations of the households

have been normalised to enable the comparison of different settlements (shape and size). The centre of a settlement has been identified as a location with historical importance, used to socially gather, for commercial exchange or as an administrative centre as stated during the survey. Limits: Due to a lack of high-resolution historical maps of the settlement, the changes in the periphery are challenging to determine. For the snapshots, the periphery is determined by the residential land in a settlement as mapped by the census of India 2011 and as observed using satellite imagery and fieldnotes in 2019. Source: Author's compilation based on survey data collected in 2019.

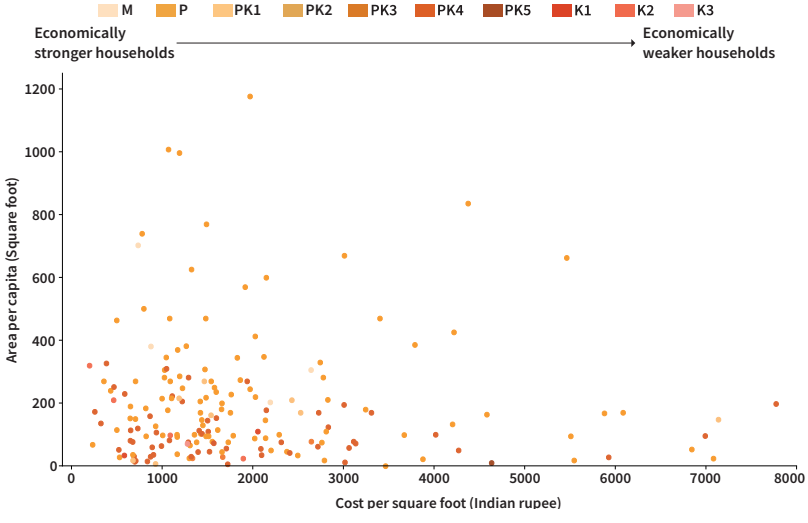


Figure 7. Current housing quality and cost of construction. The cost of construction per square foot is the total cost of the whole construction project and/or modifications made to achieve the state of the house divided by the total built-up area of the house as recorded in 2019. The area per capita is calculated by dividing the total built-up area of the house by the number of household members. The number of household members did not drastically differ between economic groups to have a significant impact on the results. Source: Author's compilation based on survey data collected in 2019. Figure legend: The figure above shows the construction quality of the houses surveyed in 2019 against the cost of construction (x-axis) and area per household member (y-axis).

From Figure 7, we can observe two main points. When vertically read, the data show economically weaker households' (PK4, PK5, i.e., composite mud and concrete structures) spending is equivalent to that of economically stronger households (P, i.e.,

brick-and-mortar structures). However, they do not achieve the same construction quality or area per household member. When horizontally read, the data show that economically stronger households (P or M) construct more than their own household needs. They usually build houses with dimensions greater than 215 square feet per person (20 square metres), the average floor area per person in most developed nations (UN DESA: Population Divison 2000). The construction frenzy has put immense pressure on the land available and compromised the quality of the built fabric in the rural settlements.

4.3. Technical Repercussions

Many technical repercussions have risen from 'movement' in and consequentially from the 'differentiation' among the rural households surveyed in Bengal. These are individually faced at the plot level and collectively faced at the planning level.

Figures 8 and 9 help to understand the growing issues of rapid land-use conversion and the limited capacity of basic service infrastructure in transforming rural settlements under the current regional planning frameworks. From Figure 8, it can be inferred that most households incrementally built on their existing residential properties, leading to the densification of older settlements (Figure 10a,b). When households move, the economically stronger households (M, P) can avail the available vacant and buildable land (Figure 10d). In contrast, economically weaker households (PK4 and the following categories) move towards fallow or low-lying areas (Figure 10c,f). In a rain-fed region of Bengal, this leads to many water-based issues on the plot (Figure 10e). Furthermore, from Figure 9, the growing problem of waste and water management systems in rural areas can be inferred (Figure 10d). Additionally, 25% of the interviewed households reported limited access to public transport or direct access to a road, even with the expansion and improvement of the rural road network (Figure 10f,g).

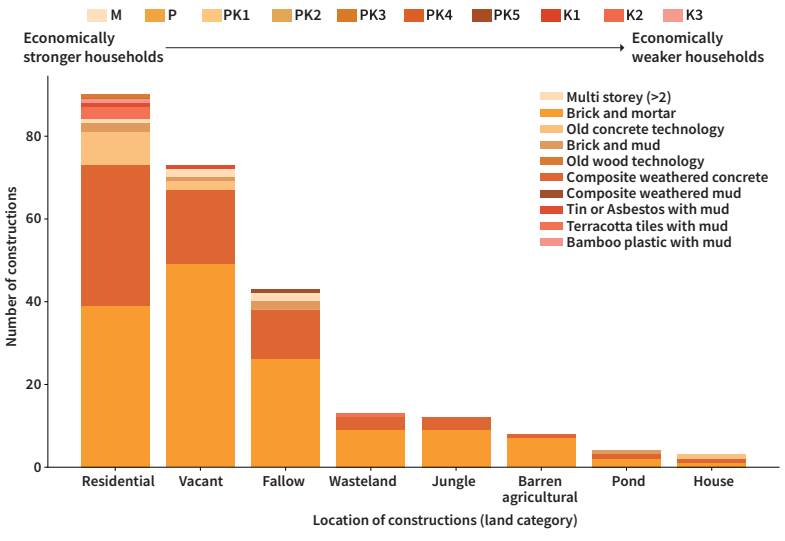


Figure 8. Land-use conversion done for houses constructed. Source: Author's compilation based on survey data collected in 2019. Figure legend: Figures 8 and 9 categorically represent the land use before housing construction (Figure 8) and planning issues on the plot subsequently faced (Figure 9) by the households surveyed. Each category has been subdivided according to housing typology in Figure 3. The y-axis represents the total number of households reporting the corresponding issues stated on the x-axis.

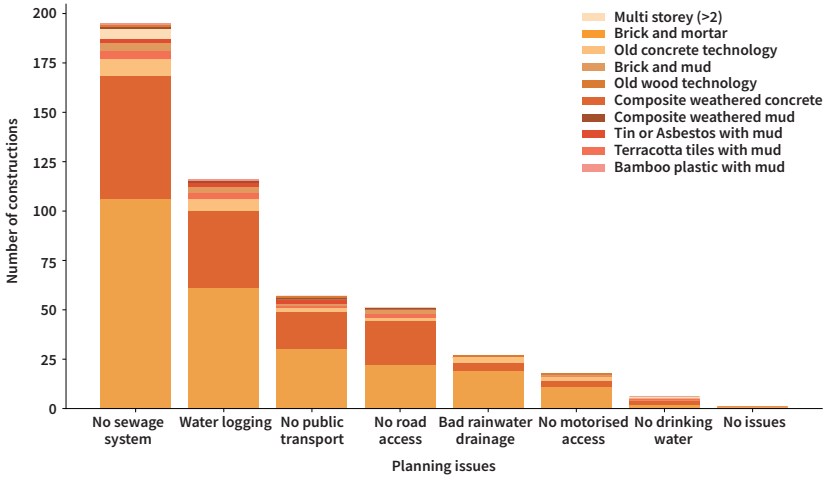


Figure 9. Planning issues faced on the plot per housing typology. Source: Author's compilation based on survey data collected in 2019.

Figure 10. Technical repercussions: (**a**,**b**) highrise, dense construction in an old settlement, alleyways as access points; (**c**) low-rise dense construction, poor connectivity; (**d**) speculative buying close to major roads—bridges used to connect roads to previously agricultural land; (**e**) waterlogged plot; (**f**) poor connectivity; (**g**) disconnected households. Source: Photos by author, 2019 fieldwork in Bengal region.

5. Discussion: Coupled Effects

This section discusses the coupled effects of the two national policies and the ensuing problematic outcomes for the sustainable development of the Bengal region. From the trends shown in the analyses (Section 4), a question arises: How do the aggregate of individual actions (like Karan and Arjun's) affect the region's transformation? More significantly, can current standalone indicators of SDGs capture these coupled effects?

Foremost, the development of regional highways improved the availability of contemporary construction knowledge, practices and materials, leading local construction preferences to change. During this time, in-place densification of the existing built fabric was carried out (shown in Figure 6a) by households who could gain capital by selling agricultural land (P, PK1 or PK3). Using contemporary, durable materials, the size and volume of their houses doubled compared to traditional to the size of the mud-and-thatch construction practised earlier. They tended to occupy the open leftover spaces within villages. This rapid densification of residential land created a labyrinth-like network of alleyways (Figure 10a,b). Nonetheless, these rapid construction projects remained unregulated. Because of its limited scope, 'The West Bengal Panchayat (Gram Panchayat Administration) Rules' introduced in 2004 has had little impact in curbing or mitigating this kind of continued densification of rural settlements (see Figure 10a–c,e,f).

The diversification of rural employment partly instigated the second movement. Increasingly large parts of the population in these transforming rural settlements are being employed in non-agriculture activities. For these households, accessibility becomes critical in deciding where to stay. Thus, they moved closer to the road (Figure 6b). Hence, former agricultural, barren, vacant, and densely overgrown vegetation is now being cleared by initial movers to set up a shop near the newly surfaced major roads to capture the rising purchasing power in rural areas (Figure 10d). Their commercial success creates a further magnet for others to settle around, thus encouraging the economically stronger households to occupy prime buildable lands—next to the road and leftover open spaces.

The second movement was also partly government-aided. The 'Housing for all by 2022' policy framework provided low-interest loan opportunities to beneficiaries who own the land. The sum given proved insufficient to house a joint family. Therefore, many economically weaker households broke down into nuclear units to benefit from the scheme, leading to land shortages within villages. Due to their low borrowing power, these households moved to highly vulnerable, usually weathered, low-lying, fallow land. Thus, the new houses built under this scheme

are mostly located on the outskirts of the settlements studied (Figure 6c) and face low accessibility and seasonal difficulties (Figure 10g). Upon asking why one would purchase such problem-ridden land, a common, happy reply was, “I could afford this”, followed by, “we are used to water [flooding]”.

Over time, the happy event of owning one’s house becomes marred by many issues where financial and technical capacities are limited. Generally, rural Bengal lacks the contemporary technical experts needed to carry out construction projects in today’s world. Due to limited funds, most households cannot afford an architect or an engineer to design their houses, leading them to rely on local masons. These local masons have attained professional knowledge by working as construction labourers on mostly apartment projects in nearby cities. This limited understanding does not help them to address the demands posed by mostly landed, standalone construction needs in rural areas. The lack of diverse knowledge hampers the spatial and structural quality of the newly constructed houses. While the economically stronger households can afford to consult an engineer (Figure 7: house typology—M), the rest mainly rely on these city-trained masons.

The capital disparity between economic groups affects their modes of construction. The economically medium households raise capital from loans, savings or by selling assets to complete their houses in one go (Figure 7: house typology—P, PK1, PK2, PK3). However, economically weaker households construct incrementally, completing different phases based on their cash flow and borrowing power. They also wait for masons and labourers to spare time at lower rates, usually during monsoons when construction demands are low (Figure 7: house typology—PK4, PK5, K1, K2, K3).

Incrementally constructed houses face multiple years of harsh climate before households can build a roof or plaster them. Generally, households following this construction method cannot afford the mason’s daily wages for a prolonged period. Thus, the material they buy in bulk to reduce the costs remains unused between these shorter construction periods dictated by the mason’s schedule. Furthermore, under the housing policy, capital is provided by the government to start construction but is insufficient to complete it. The discrepancy between the projected construction cost within the policy framework and the actual construction cost further increases a household’s debt to local lenders. Many households surveyed from this economic group painfully described borrowing capital from local money lenders and construction material stores at as high as 30 percent interest rates and sometimes pawning their few prized items.

Nevertheless, low affordability also has its upsides. The prolonged construction periods helped economically weaker households optimise their house design suggested by masons. In contrast, the economically stronger and medium households were usually dissatisfied with the spatial quality of their newly constructed houses. Unable to visualise the future conditions, these households readily accept the apartment-like layouts proposed by the masons. For a landed and standalone unit, the layout is riddled with corridors, crammed linear spaces and larger-than-required rooms, which only become apparent to homeowners after the construction project has been finished. Poorly ventilated and with no ducts to keep the concrete roof from heating up, these households build even more storeys to find respite from hot summer days (see Figure 10a–c). Additionally, due to the lack of soil testing, many structural issues go unaddressed, leading to either over usage of materials or rising structural problems.

With every economic group adding to the construction frenzy, the rural settlements of Bengal are rapidly transforming, but local frameworks remain unprepared to manage this change. With limited technical expertise and financial resources allocated to rural governance offices (Gram Panchayat), rural households lack basic infrastructures (see Figure 9). National planning guidelines do not mandate the provision of sewage systems, water systems, street lighting, rainwater or flood planning, or maps of land vulnerable to climate change for rural development and planning. Instead, the sustainability of these transforming settlements greatly depends on the local leadership's ability and willingness to provide these amenities. Therefore, most households that lack these connections self-construct short outlets to nearby ponds or tanks to manage their water and waste needs. Additionally, even with multiple road development schemes implemented, commuting is compromised. Most public or semi-public transportation options do not operate after sunset. Subsequently, most neighbourhoods turn dark, sometimes dimly lit by stores still open, and there is a limited female presence outdoors.

Moreover, as the newly surfaced roads are constructed and the concretisation of land continues, multiple disruptions are created. Newly built houses encroach upon adjoining public spaces, disrupting already thinning alleyways within these settlements (Figure 10a–c). With encroachments, these alleyways can barely accommodate a pedestrian and a two-wheeler passing by simultaneously. Many households recounted instances where an ambulance could not reach their house because of the width of their approach roads. This dire fact was confirmed when I witnessed a patient being carried on a small wooden cart through an alley to his mansion-sized home. Additionally, such encroachments block drainage routes into

nearby ponds or diminished open spaces (Figure 10e), increasing flooding frequency within these densely transformed settlements. Such settlements, usually already declared as census towns and if recognised as an urban body in the next census of 2021, would be an addition to India's already problematic relationship with timely sustainable planning.

6. Conclusions: The Missing Link between Regional Planning and SDG 11

Sustainable development is a dynamic and complex problem. Standalone indicators alone cannot measure the sustainability of a region with layered systems, actors and agencies in place. The cognitive blind spots towards these multiplicities fail to capture the coupled effects of siloed development policies, like road and housing, that further entrench the most vulnerable with each policy cycle. Even though national road and housing policies seemingly contribute to India's commitment to SDG (NITI Aayog 2017), they fail to address their primary aims of reducing vulnerability, as shown here through Bengal's case.

Using the housing practices from 197 surveyed households, I trace the 'movements' of the construction frenzy that ensued by coupling the road and housing policies implemented in the region, producing differentiated outcomes per income group (see Section 4). While economically stronger households occupy prime land within the settlements or next to newly built or improved roads, the economically weaker households are pushed towards the flood-prone peripheries and away from major roads in the settlements (Figure 6a–c). This contrast in spending power is reflected in the housing quality they achieved. On the one hand, households with low capital flow spend a higher percentage of their wealth than their higher-income counterparts. However, they achieve lower housing quality (see Figure 7), which weathers during the long and incremental construction process. On the other hand, capital-intensive households overbuilt, creating wasteful spaces they do not need or use. These contradictions also arise from the expertise available to each group (see Section 5).

These coupled effects have created a domino effect of planning and governance failure at the regional scale. The movement of and differentiation in economic groups has increased land-use conversions, settlement size, urbanisation, and inaccessibility to basic services for the most vulnerable. With limited technical expertise and financial resources, rural governance agencies struggle to mitigate the multiple 'technical repercussions' felt at the household, plot and settlement levels (see Figures 8 and 9). Many of these incurred adversities are the underreported or unreported indicators of SDG 11.

The complexity of regional sustainability remains unanswered by current assessments of SDGs, most apparent in SDG 11, whose individual indicators have correlating outcomes. These standalone indicators allow for positively skewed, selective reporting, as seen in the Indian case. Furthermore, with many regions across the world transitioning (Denis and Zérah 2017), these coupled effects trickle down to other territories, triggering planning and governance issues in these jurisdictions as well. With such domino effects usually ignored by policy frameworks, these transformed territories remain unaccounted for in the policy-focused assessments of SDG.

7. Conclusions

There are multiple advantages to viewing the standalone indicators through the lens of coupling effects. Foremost, a fairer assessment of the targets achieved can be carried out. Second, with a multi-faceted and global scope, the SDG framework could ameliorate the discrepancies between policy aims and reporting mechanisms (Loewe 2012) by acknowledging the correlation between SDG indicators at the regional, national and global scale, independent of the reporting carried out by individual development policies of the state. Third, by associating the indicators, we include the positive and the correlated negative impacts of policies implemented, reducing reporting biases from its assessment. Additionally, policy mobility between regions (and countries) targeting similar goals with a similar local context could have a more productive knowledge exchange. Furthermore, a reliable cross-comparison between countries could be carried out under the SDGs framework, providing a clearer global picture of the sustainable development goals achieved.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy concerns of participants.

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