

Quantifying the Regional Dynamics and Redistribution of Physical Vulnerability in Least Developed Countries

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Abstract

In the margins of the accelerating development of digital technology worldwide are the Least Developed Countries (LDCs), which continually face an exacerbated risk crisis at the intersection of rapid rural-urban growth, underlying physical vulnerability, and intensifying climate hazards. Despite decades of international development commitments, the rate of built-up expansion across LDCs has significantly outpaced efforts to transition equitably towards lower physical vulnerability, leaving billions of people exposed to increasing physical, socio-economic, and environmental risks. To understand the evolution of physical vulnerability over the past five decades, this chapter presents a comprehensive, multi-decadal quantitative spatiotemporal analysis of regional building stock composition and its redistribution dynamics across LDCs, examining aggregate regional trends, cross-country variation, and context-specific dynamics in landlocked geographies, small island developing states, African sub-regions, and post-disaster settings. Using annualised and aggregate proportional change metrics, our findings reveal that compositional redistribution has shifted predominantly towards locally sourced materials for earthen construction, which are of high vulnerability. Varying rural and urban development patterns emerge as primary drivers of redistribution trajectories, while landlocked and island nations face uniquely compounding disadvantages due to material accessibility, affordability, and resource constraints. In post-disaster contexts, the persistent prevalence of unreinforced masonry confirms that disaster occurrence has a localised effect on reshaping construction practices without robust institutional governance. These findings provide the most granular spatiotemporal evidence to date on whether LDCs are achieving significant redistribution progress and offer a quantified, prospective basis for redesigning regional vulnerability management strategies and international risk reduction frameworks that are adaptive and sensitive to the diverse and challenging realities of the built environment in LDCs, both towards and beyond 2030.

Keywords: physical vulnerability, probabilistic, least developed countries, remote sensing, deep learning, spatiotemporal

JEL Classification: O15 , O18 , O20 , Q54 , Q56 , R11 , R14 , R31 , C53 , C55 , D81 , O33 , C45

MSC Classification: 68T07 , 68T09 , 62H35 , 60G60 , 62M30 , 62P12 , 86A32 , 91B76 , 90B15

1 Data and Code Availability

Two parts of spatiotemporal data are publicly available at <https://doi.org/10.5281/zenodo.16608380> (Dimasaka et al. 2025a) and <https://doi.org/10.5281/zenodo.16695059> (Dimasaka et al. 2025b). The code is also accessible at <https://github.com/riskaudit/GraphVSSM> under MIT license.

Acknowledgments

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References

- Dimasaka J, Geiß C, So E (2025a) METEOR 2.5D: An Open Geospatial Dataset of Spatiotemporal Evolution of Physical Vulnerability in UN-recognized Least Developed Countries (as of 2020) at Five-year Intervals, 1975-2030 (Part 1 of 2) . <https://doi.org/10.5281/zenodo.16608380>, URL <https://doi.org/10.5281/zenodo.16608380>
- Dimasaka J, Geiß C, So E (2025b) METEOR 2.5D: An Open Geospatial Dataset of Spatiotemporal Evolution of Physical Vulnerability in UN-recognized Least Developed Countries (as of 2020) at Five-year Intervals, 1975-2030 (Part 2 of 2) . <https://doi.org/10.5281/zenodo.16695059>, URL <https://doi.org/10.5281/zenodo.16695059>

A Annual Development Profile by Continent, Country, and Vulnerability

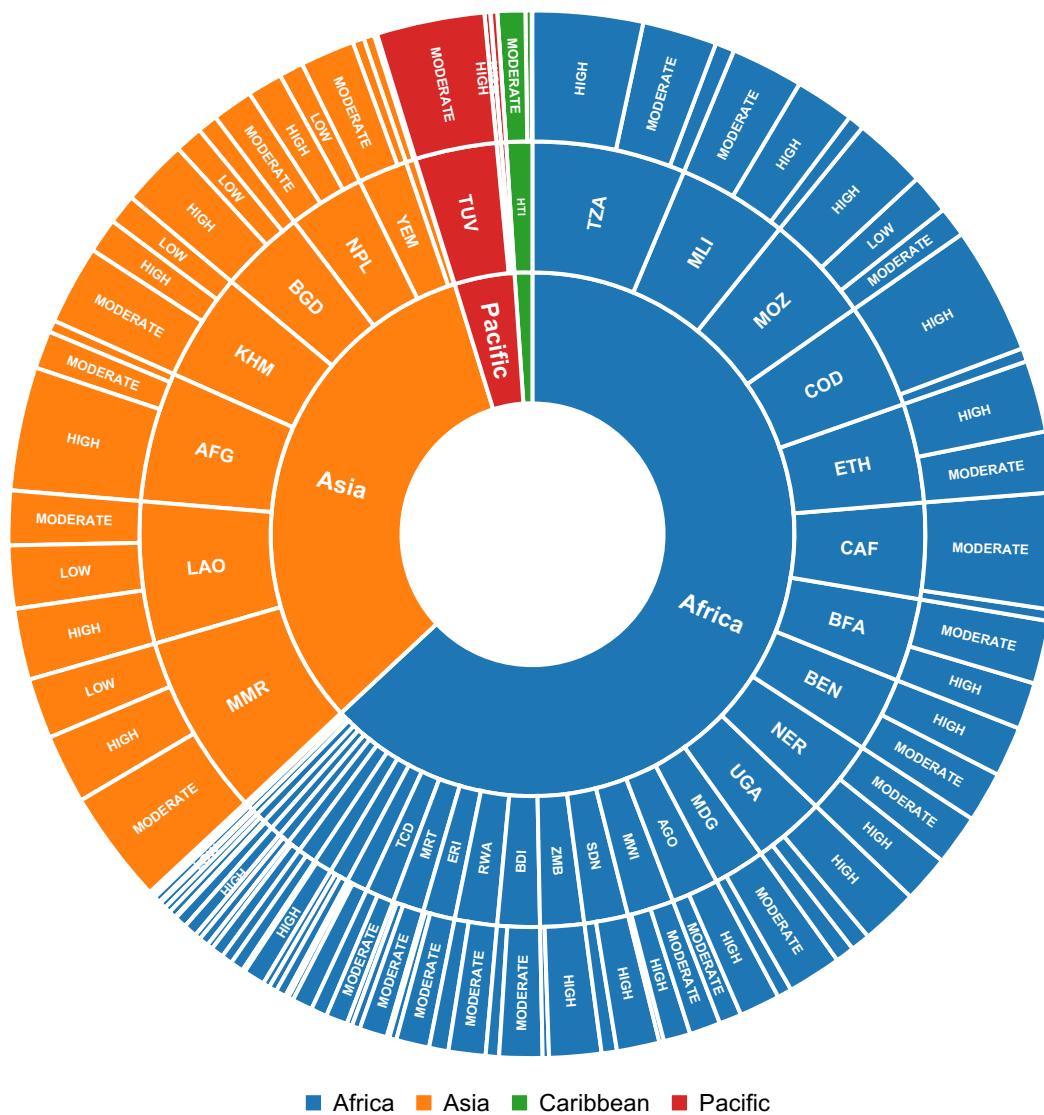
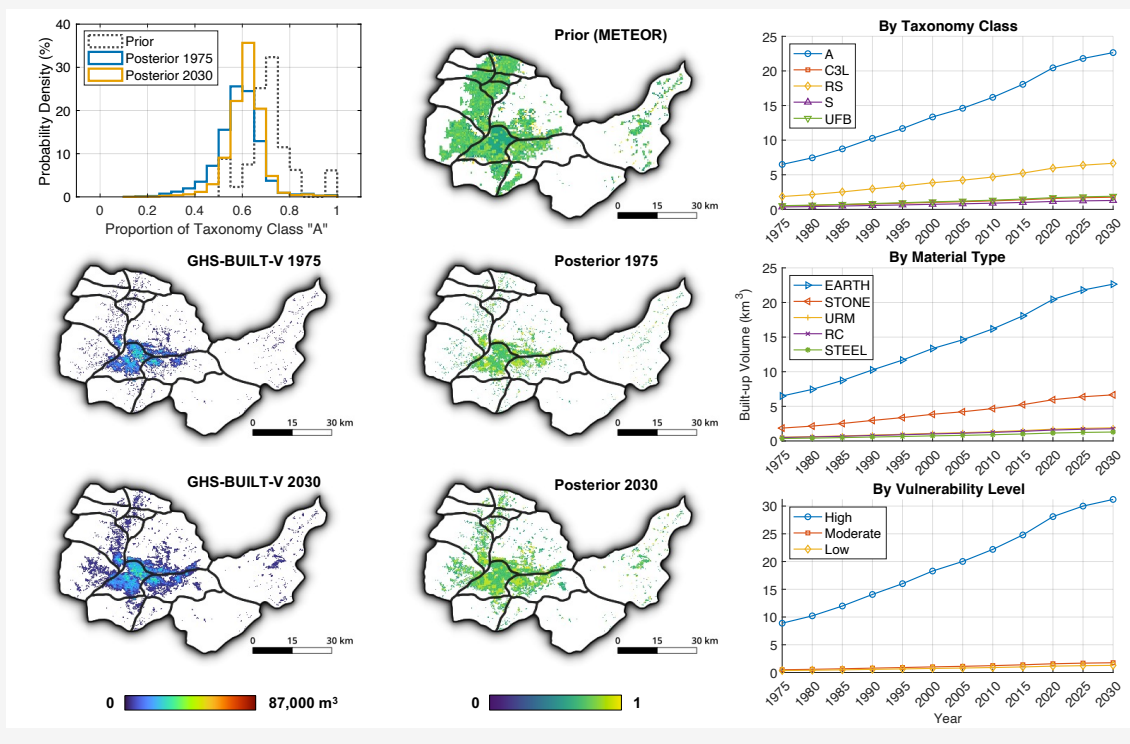


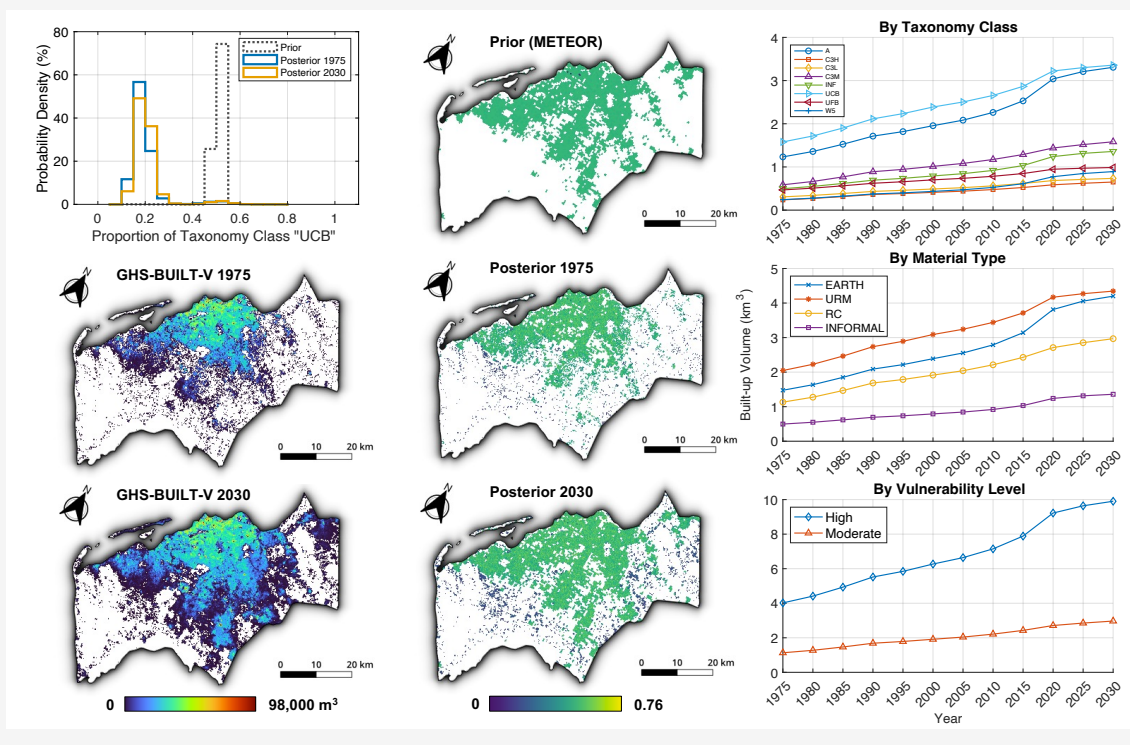
Fig. A.1: Three-level composition of annual development profiles across LDCs by continent, country, and vulnerability level.

B Country-Specific Physical Vulnerability Profiles

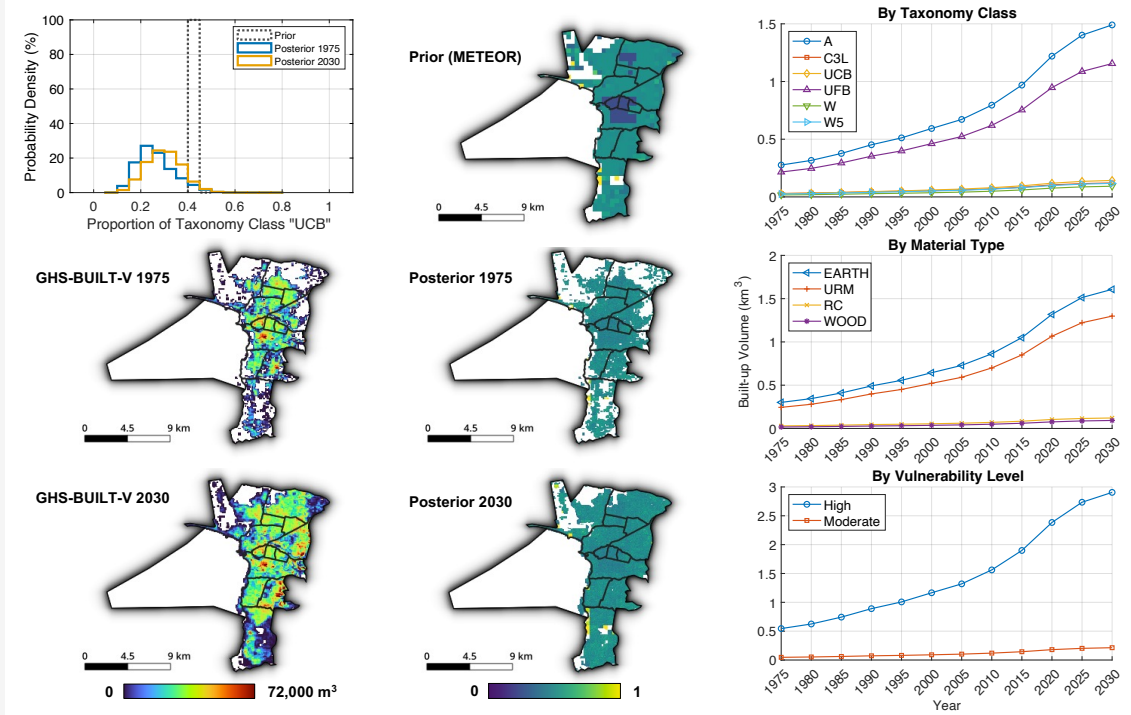
B.1 AFG: Kabul, Afghanistan



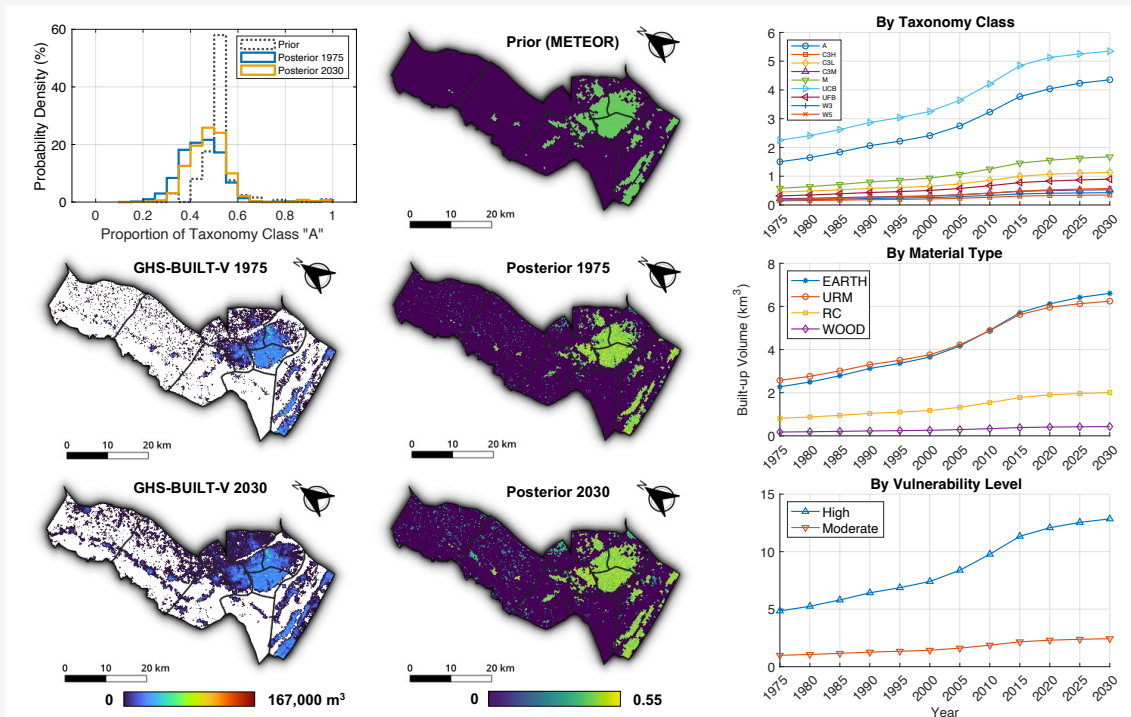
B.2 AGO: Luanda, Angola



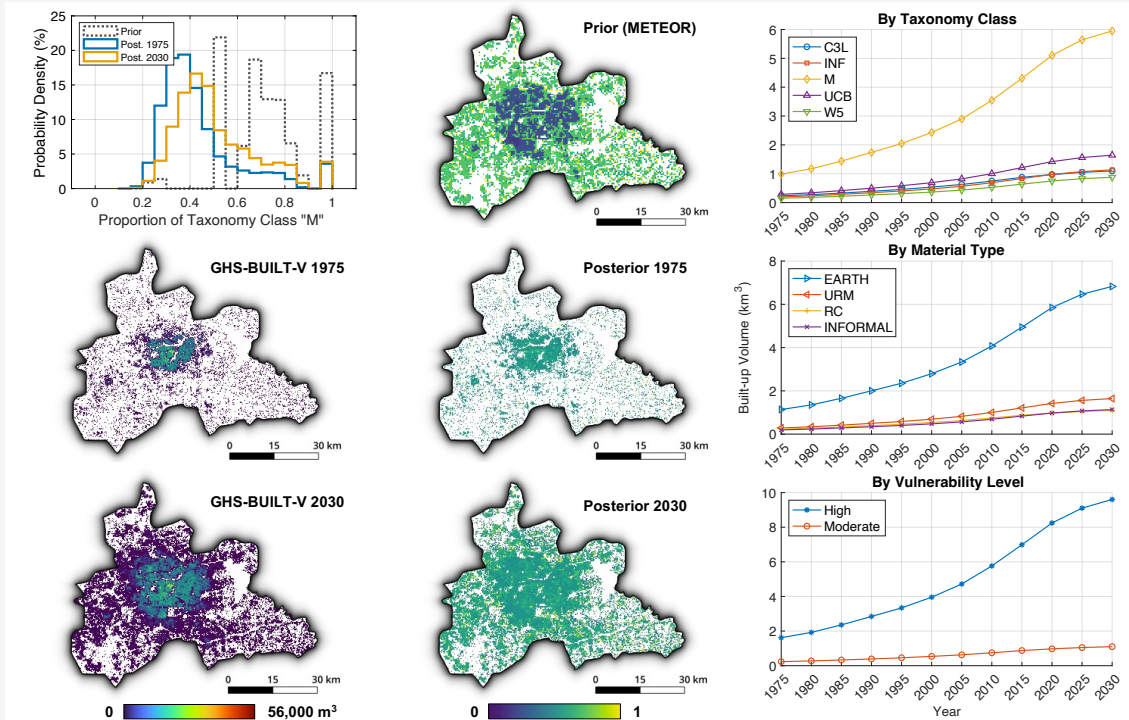
B.3 BDI: Bujumbura Mairie, Burundi



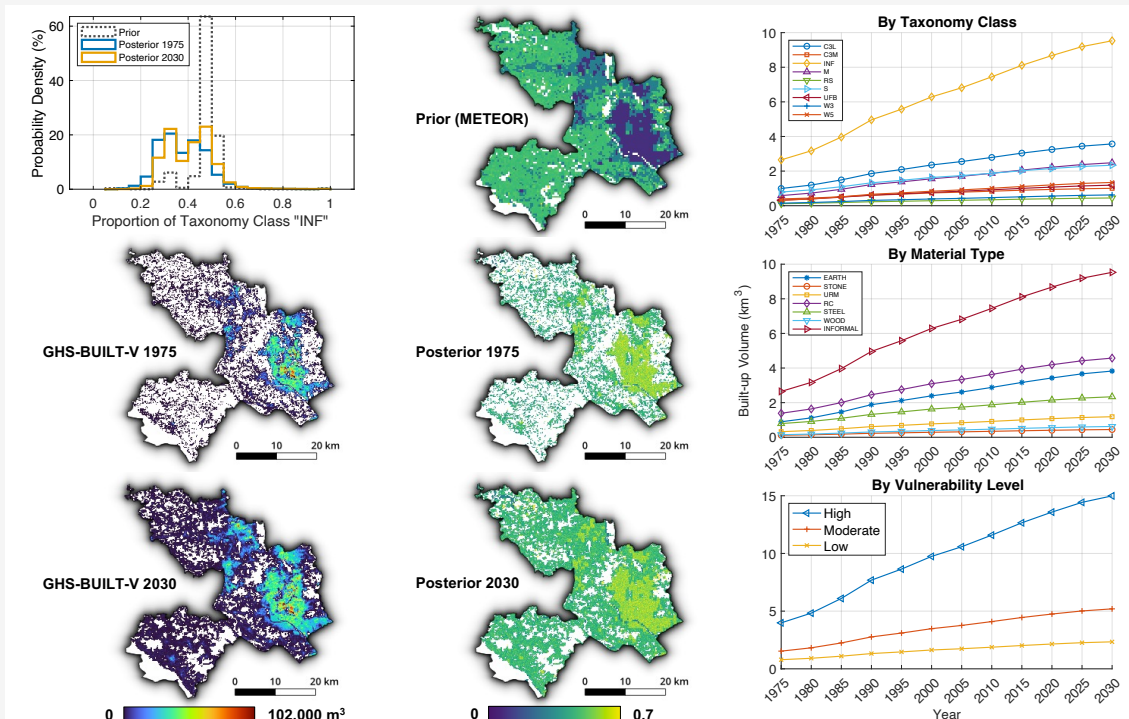
B.4 BEN: Ouémé, Benin



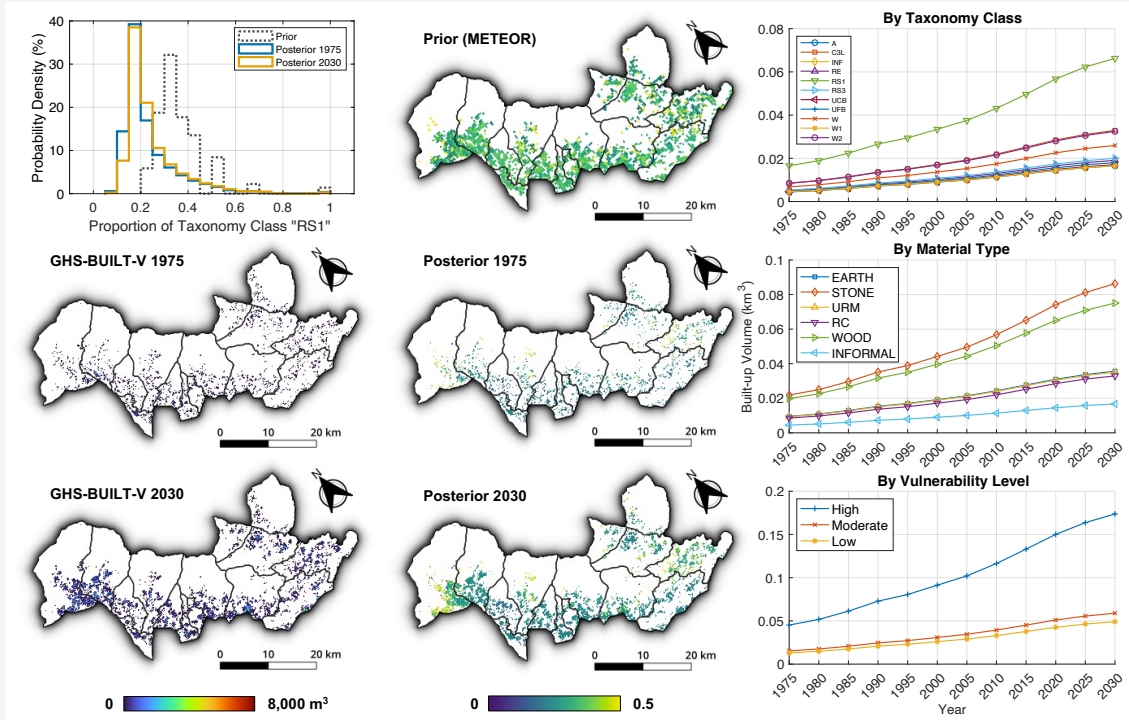
B.5 BFA: Centre Region, Burkina Faso



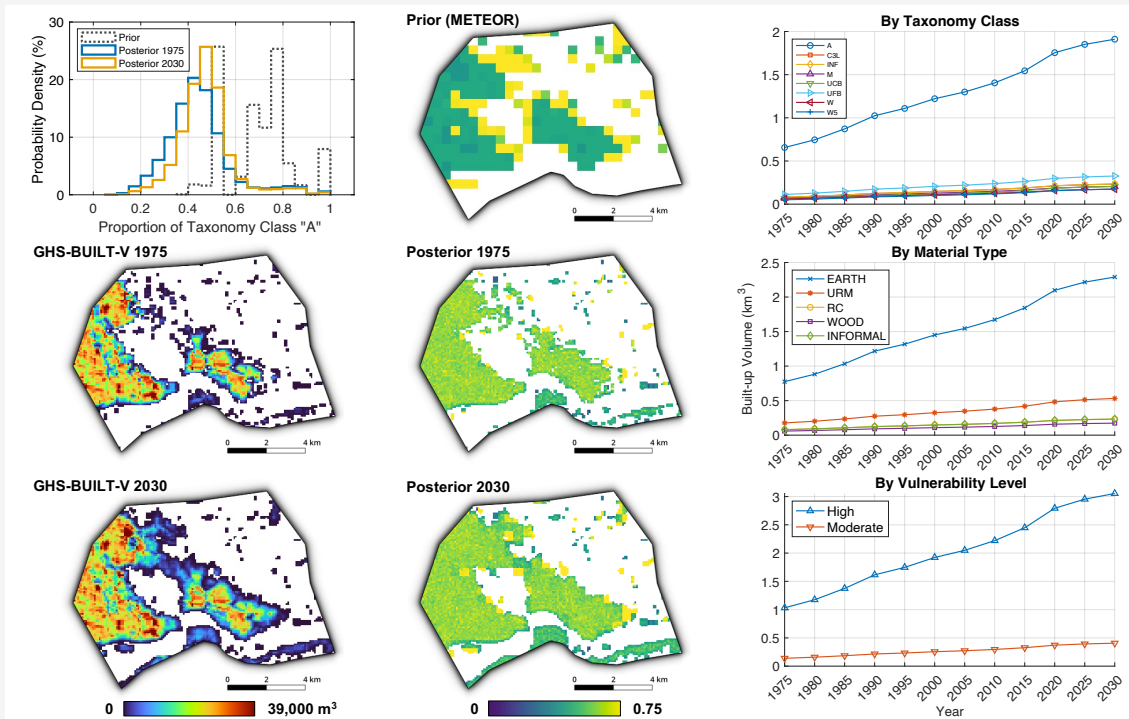
B.6 BGD: Dhaka City, Bangladesh



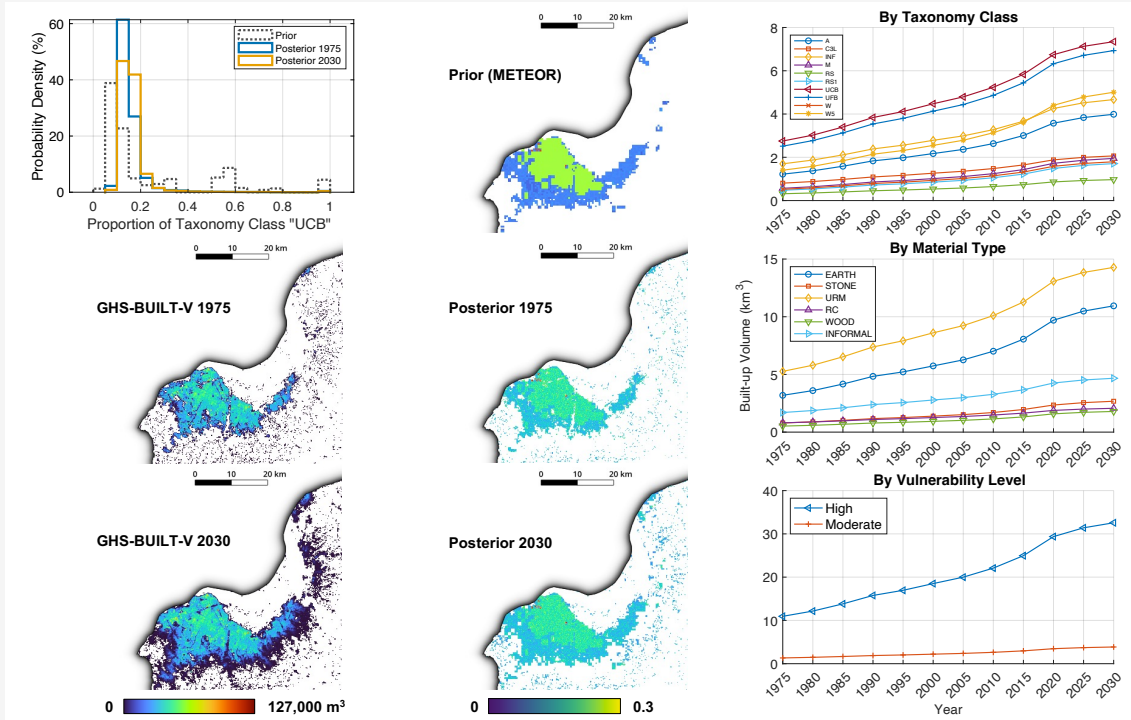
B.7 BTN: Samtse, Bhutan



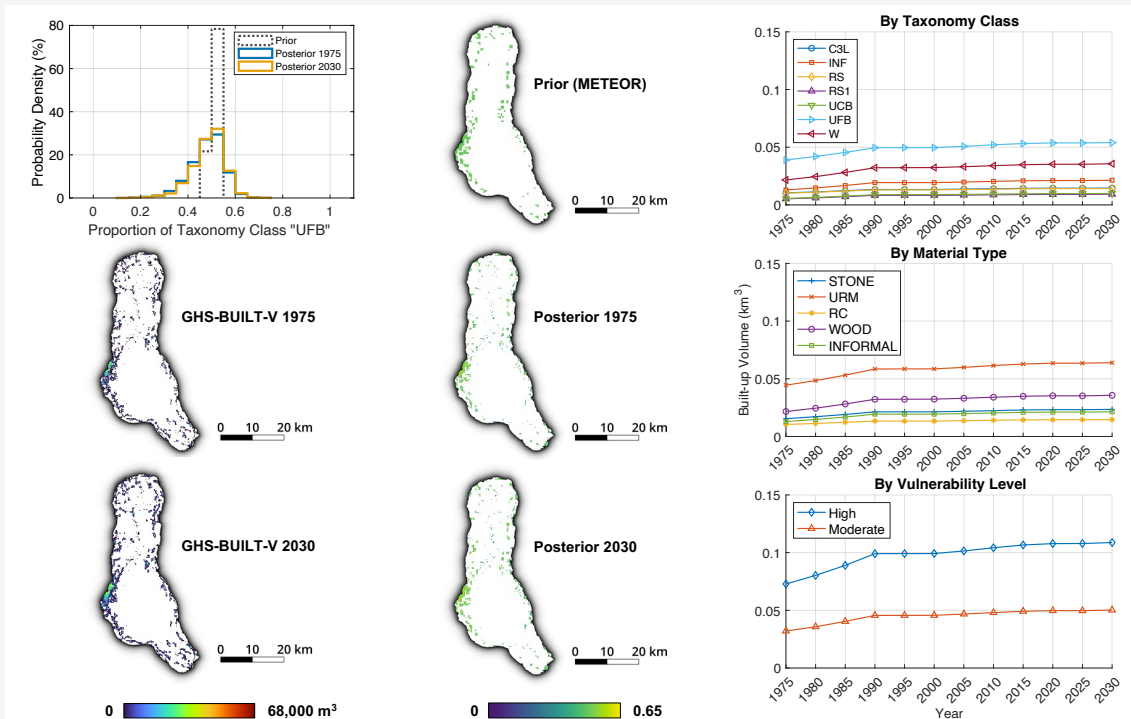
B.8 CAF: Bangui, The Central African Republic



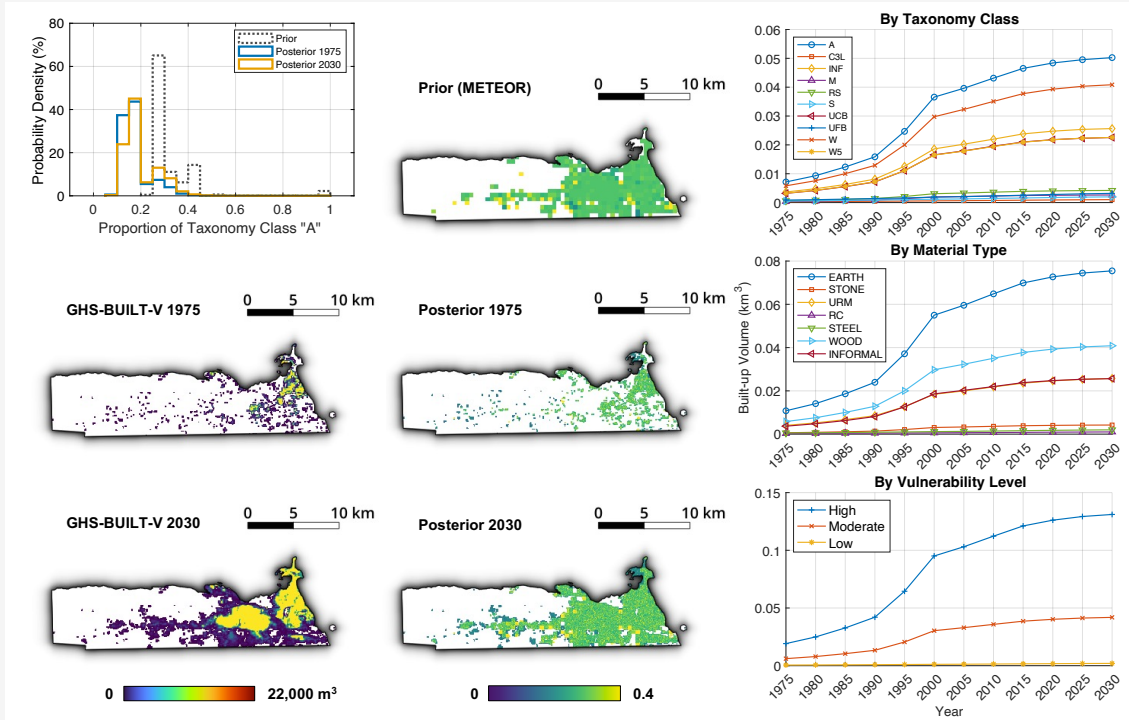
B.9 COD: Kinshasa, Democratic Republic of the Congo



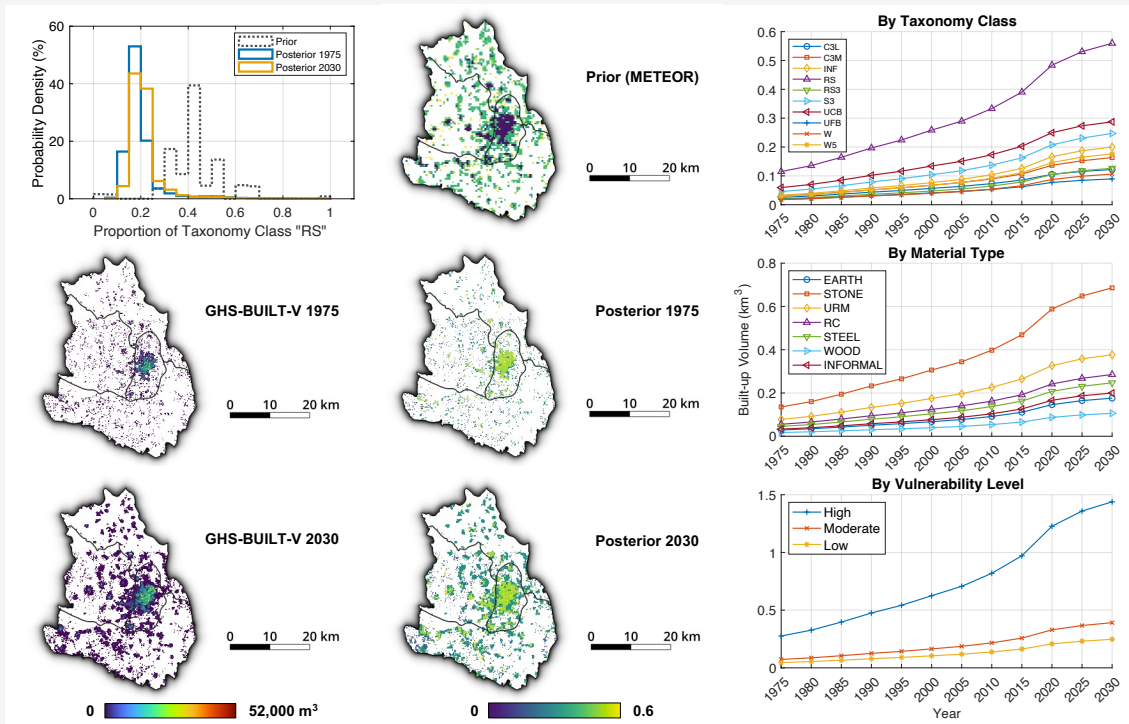
B.10 COM: Grande Comore, Comoros



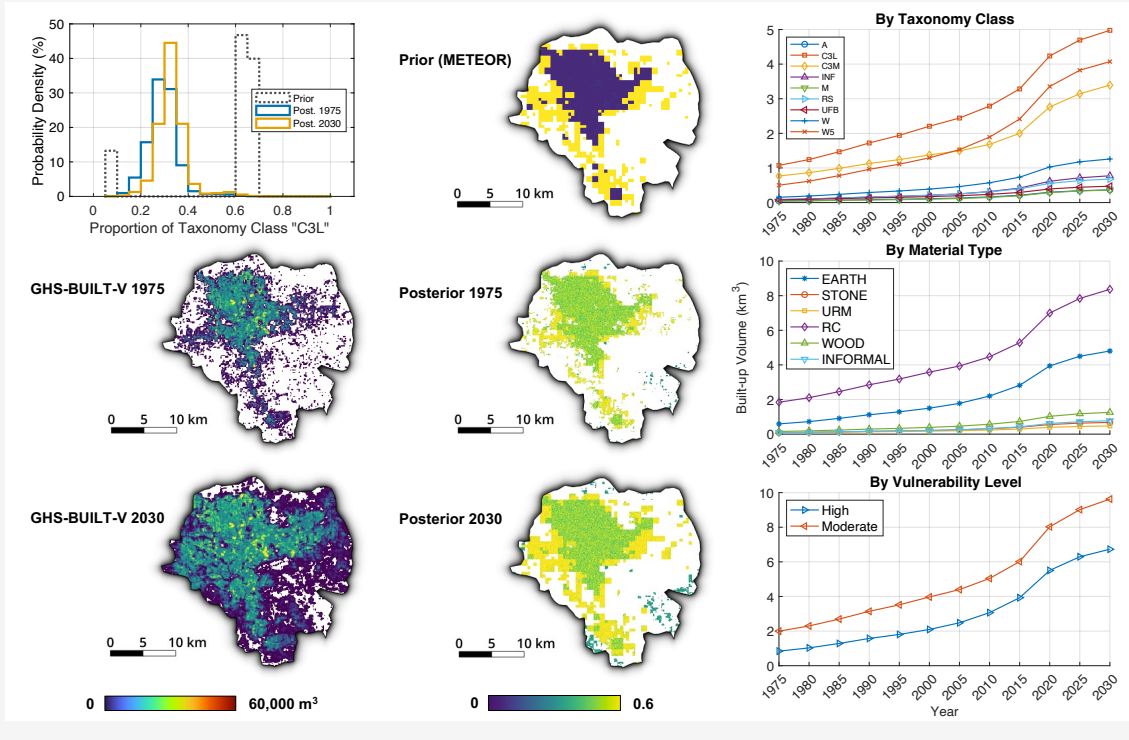
B.11 DJI: Djibouti



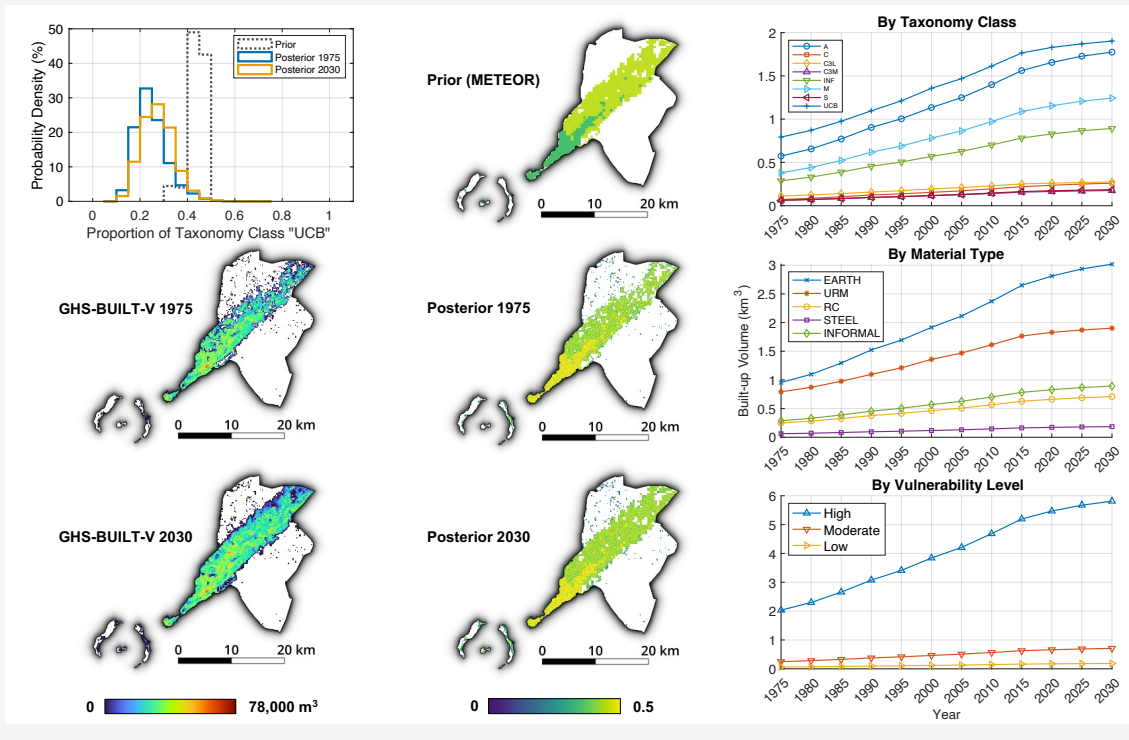
B.12 ERI: Maekel, Eritrea



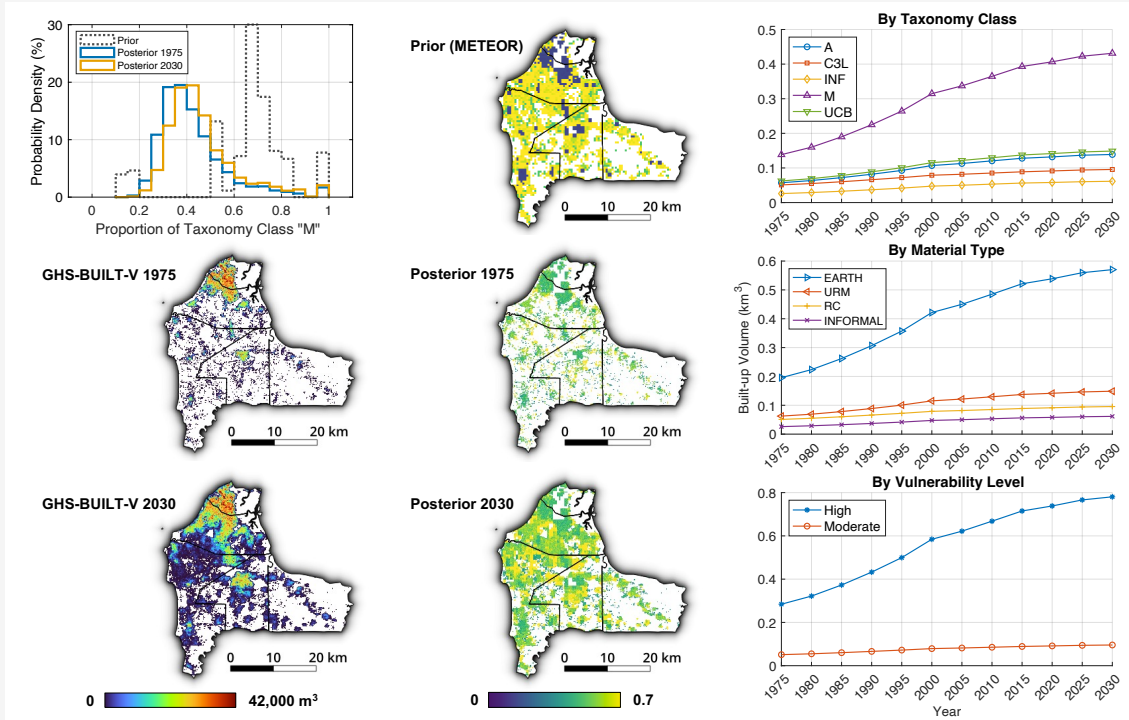
B.13 ETH: Addis Abeba, Ethiopia



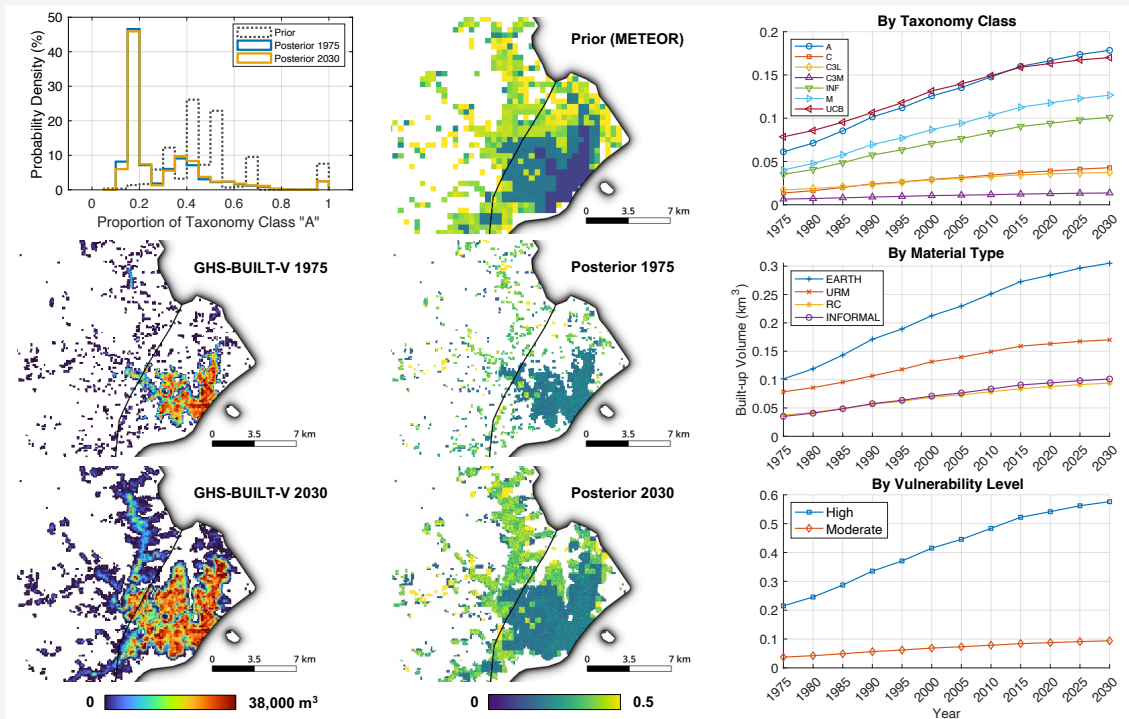
B.14 GIN: Conakry, Guinea



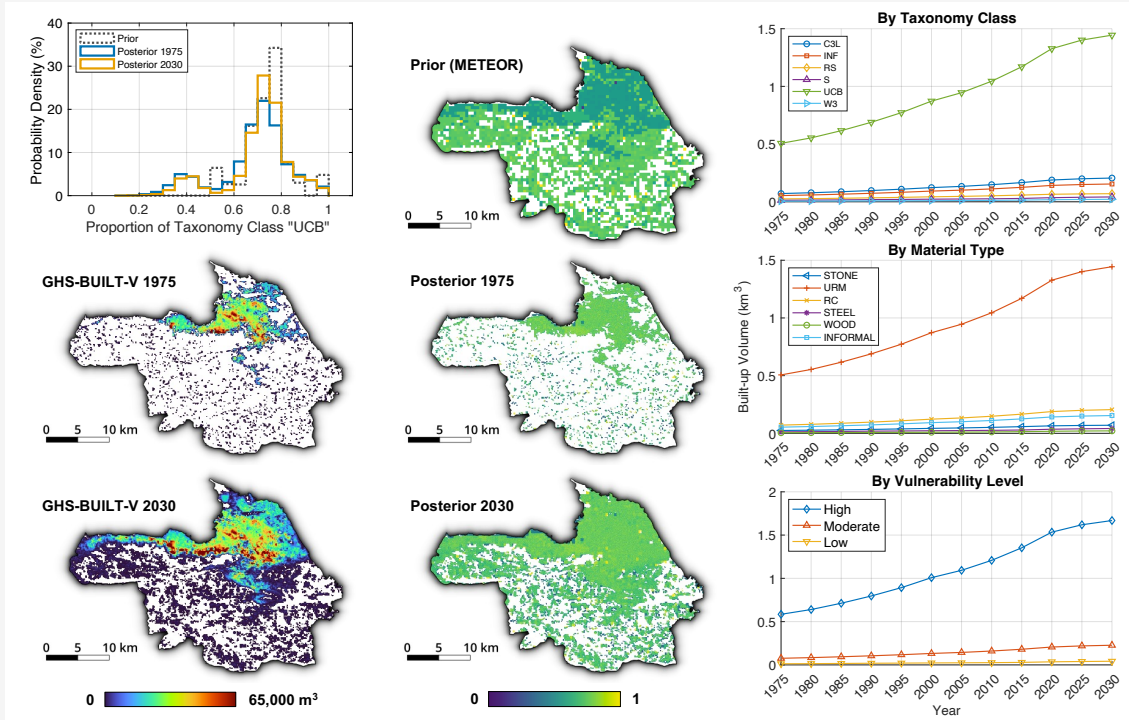
B.15 GMB: Banjul & Kombo, The Gambia



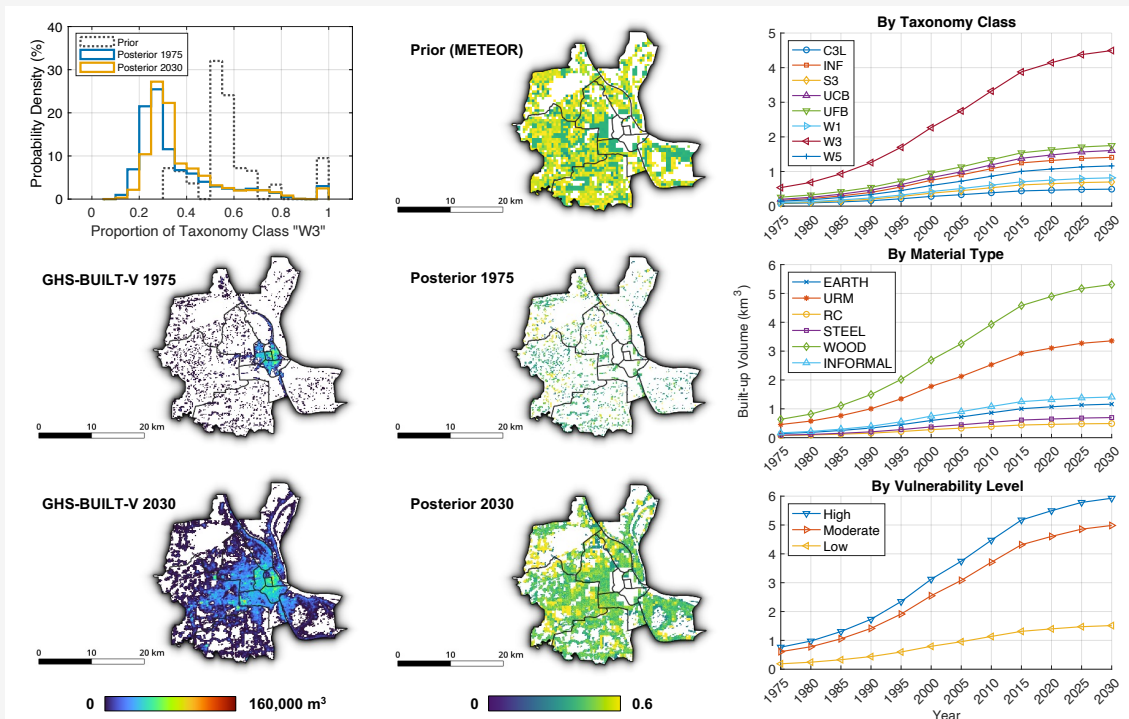
B.16 GNB: Bissau & Biombo, Guinea-Bissau



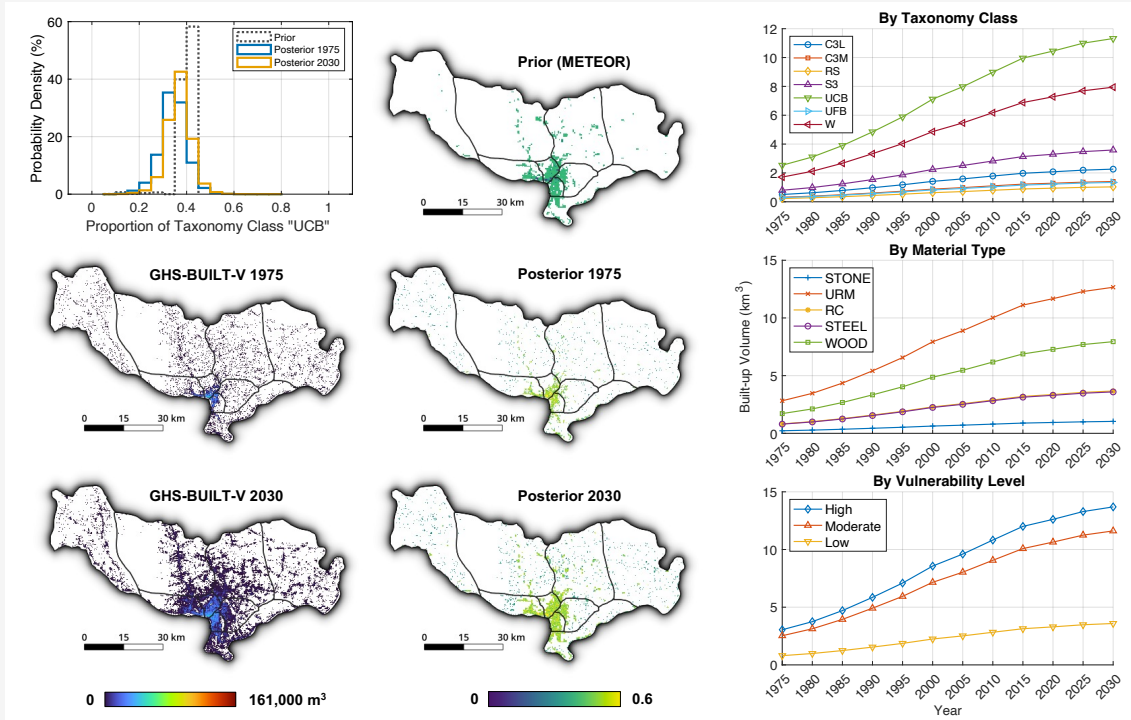
B.17 HTI: Port-au-Prince, Haiti



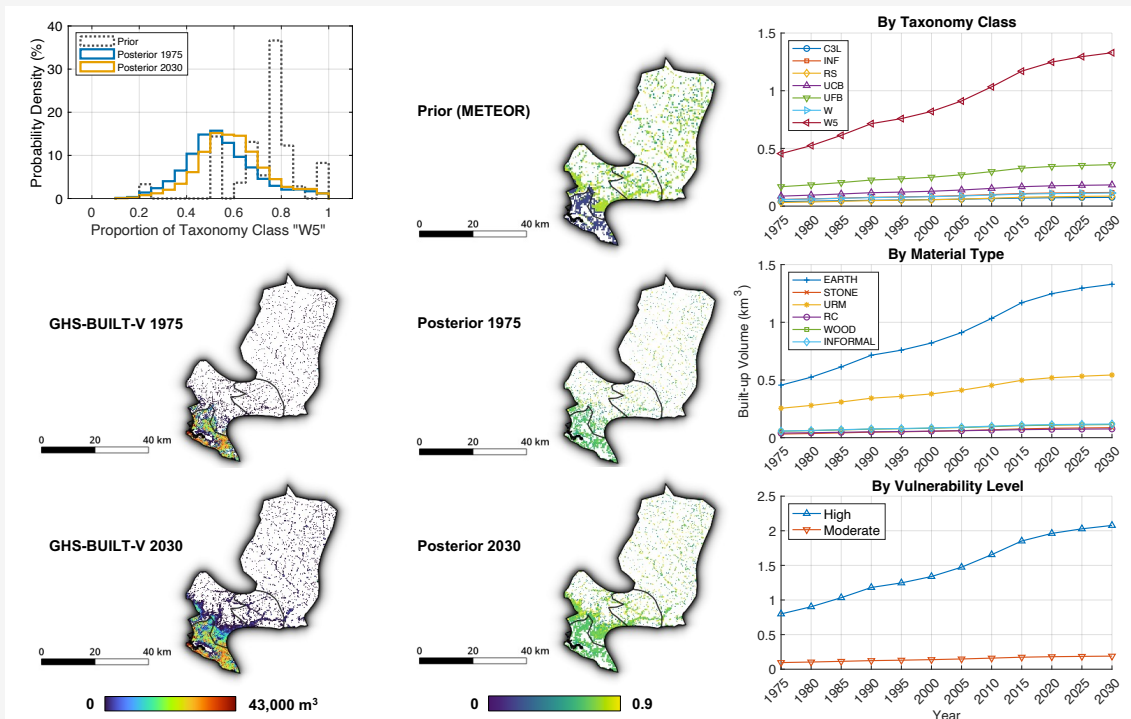
B.18 KHM: Phnom Penh, Cambodia



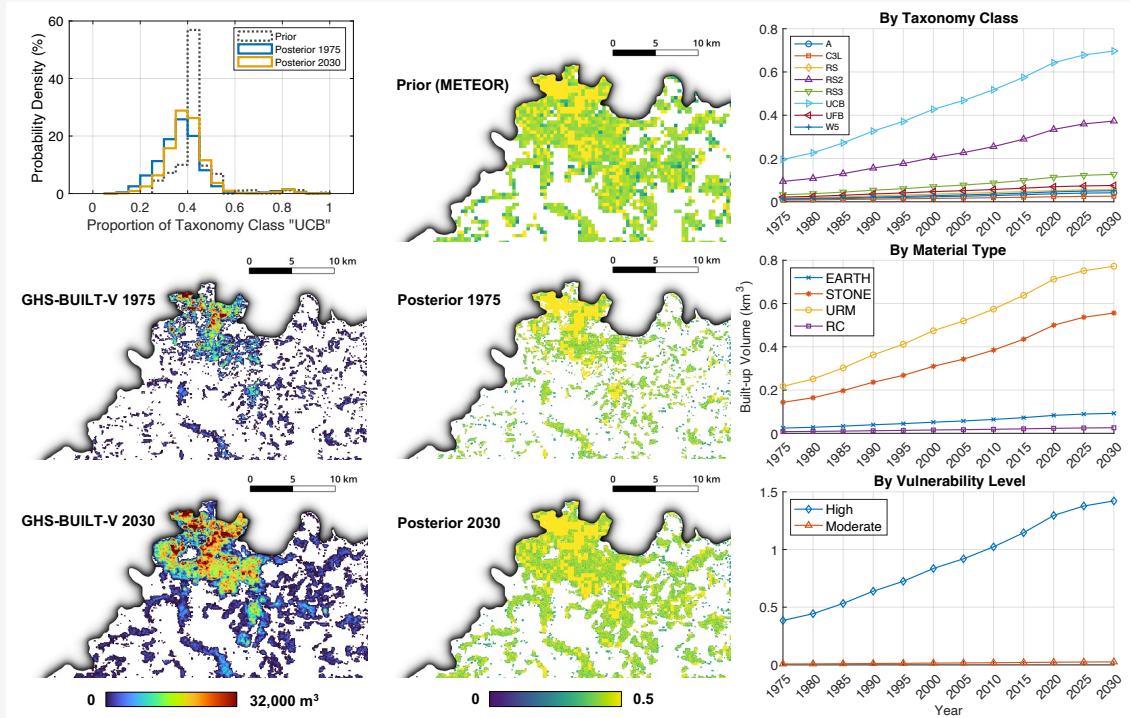
B.19 LAO: Vientiane, Laos



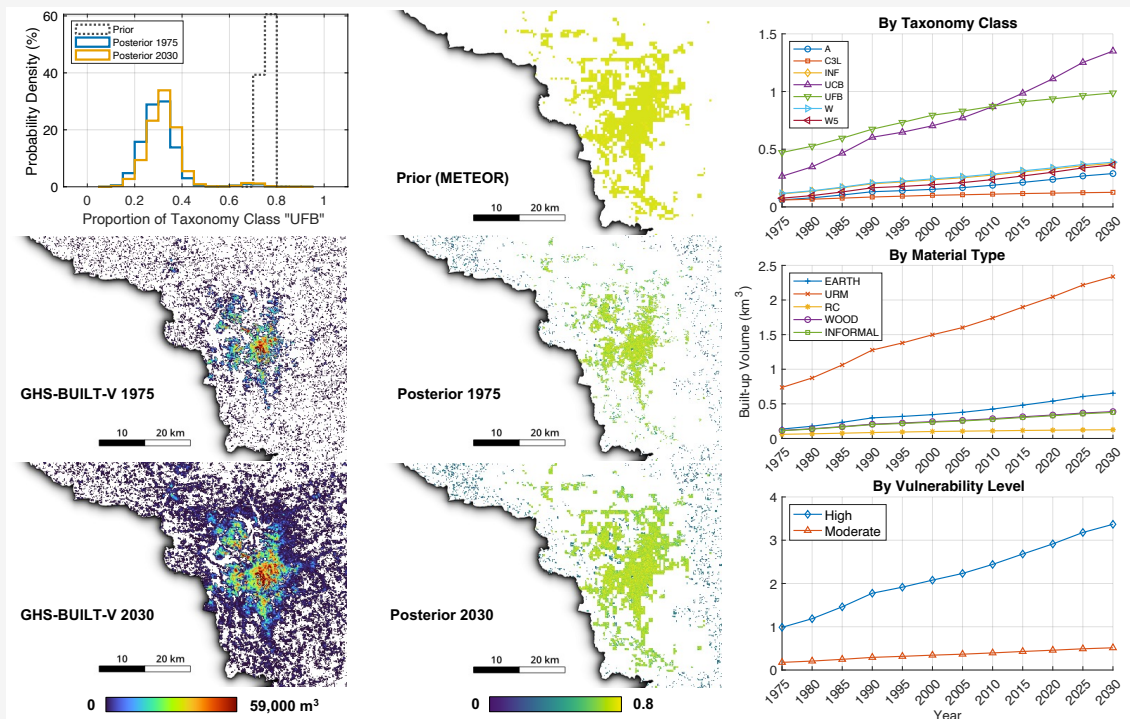
B.20 LBR: Montserrado, Liberia



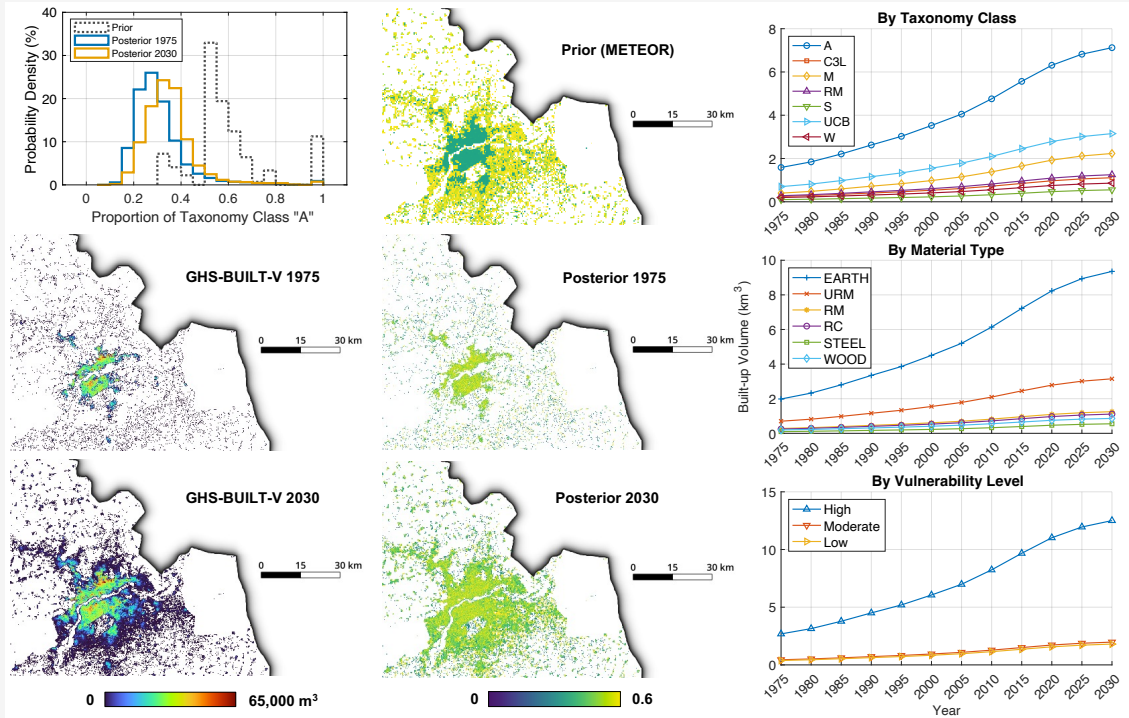
B.21 LSO: Maseru, Lesotho



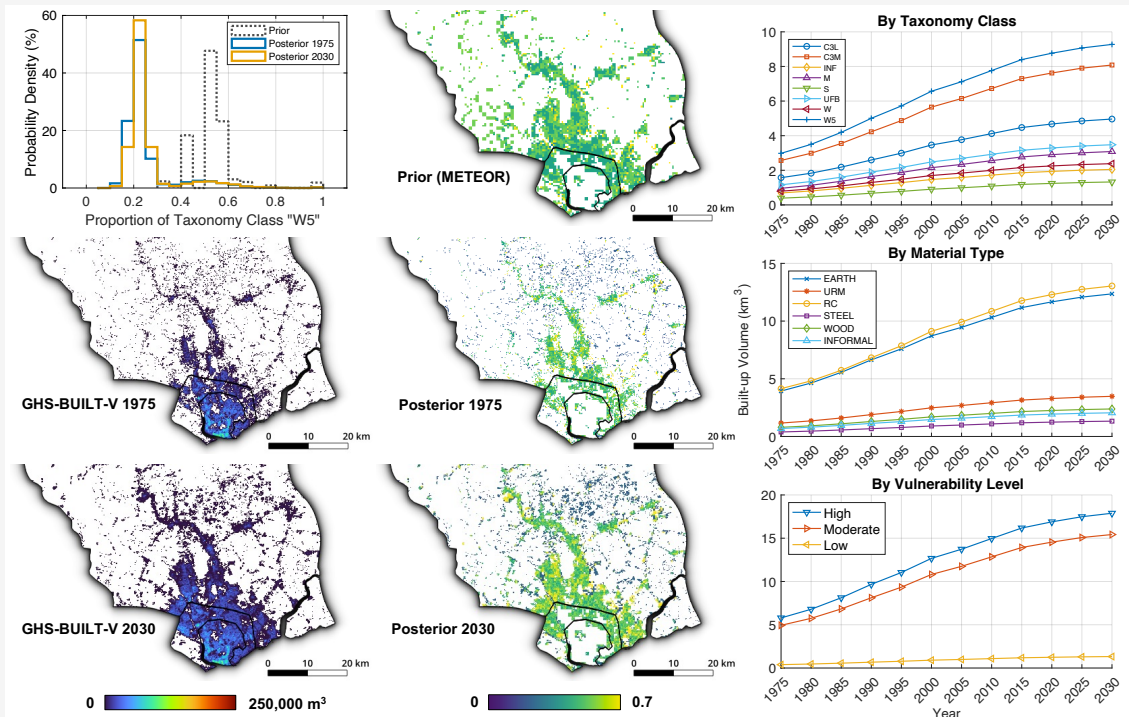
B.22 MDG: Analamanga, Madagascar



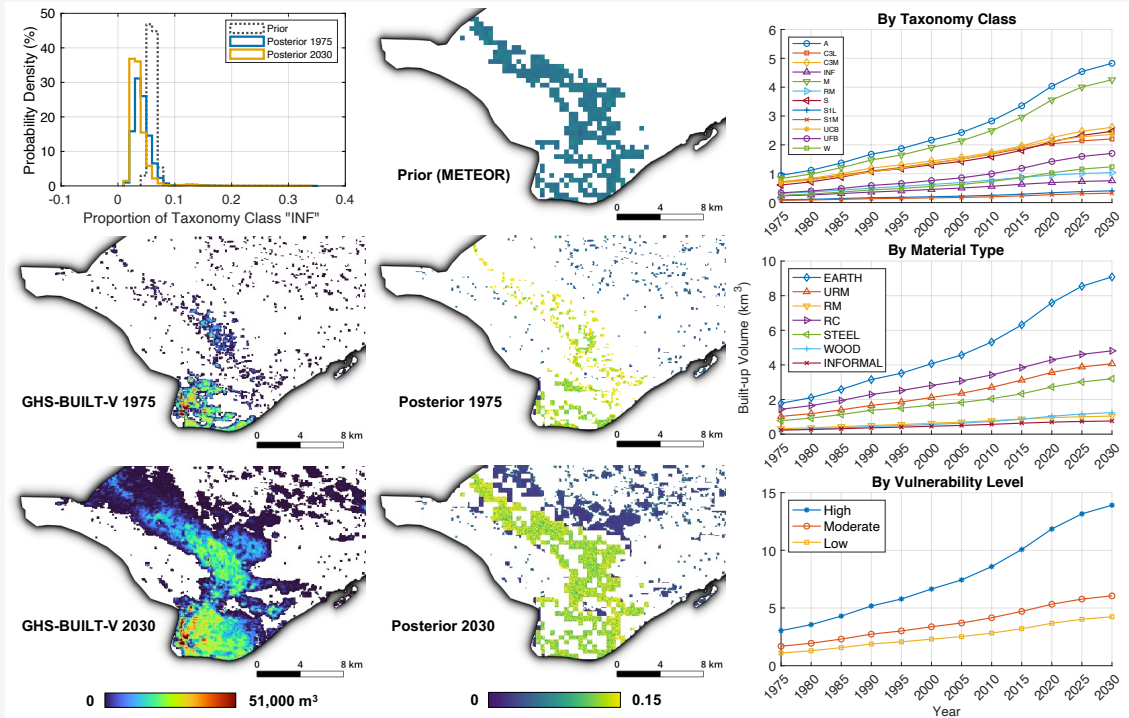
B.23 MLI: Bamako & Kati, Mali



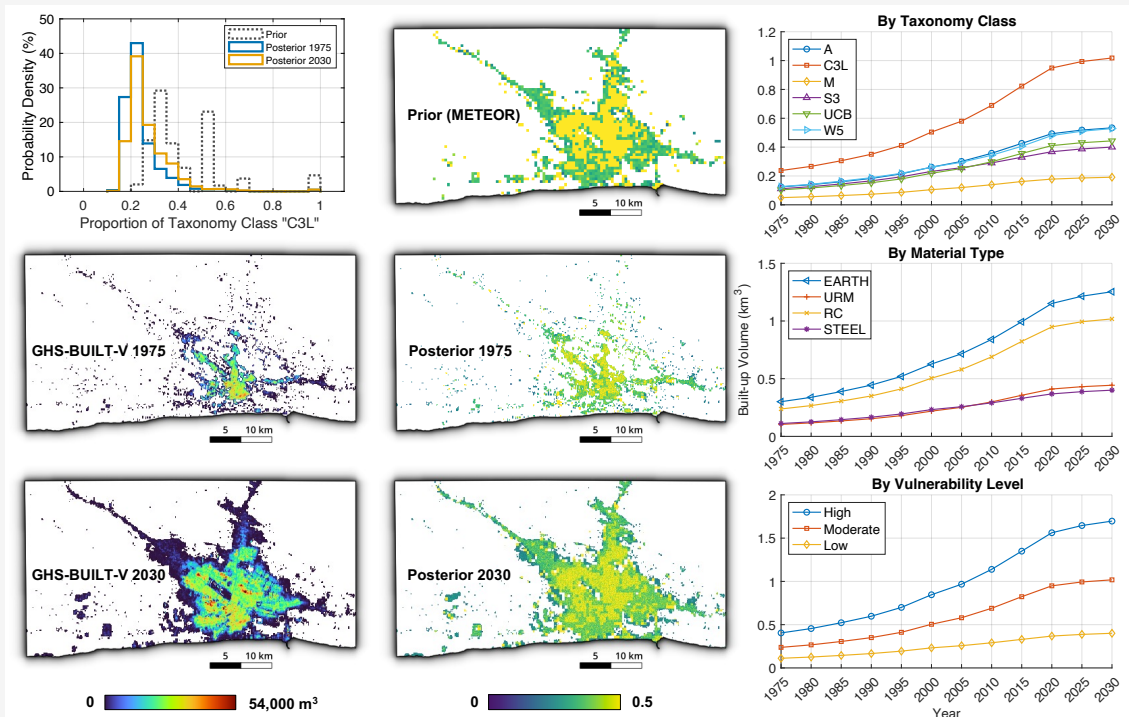
B.24 MMR: Yangon, Myanmar



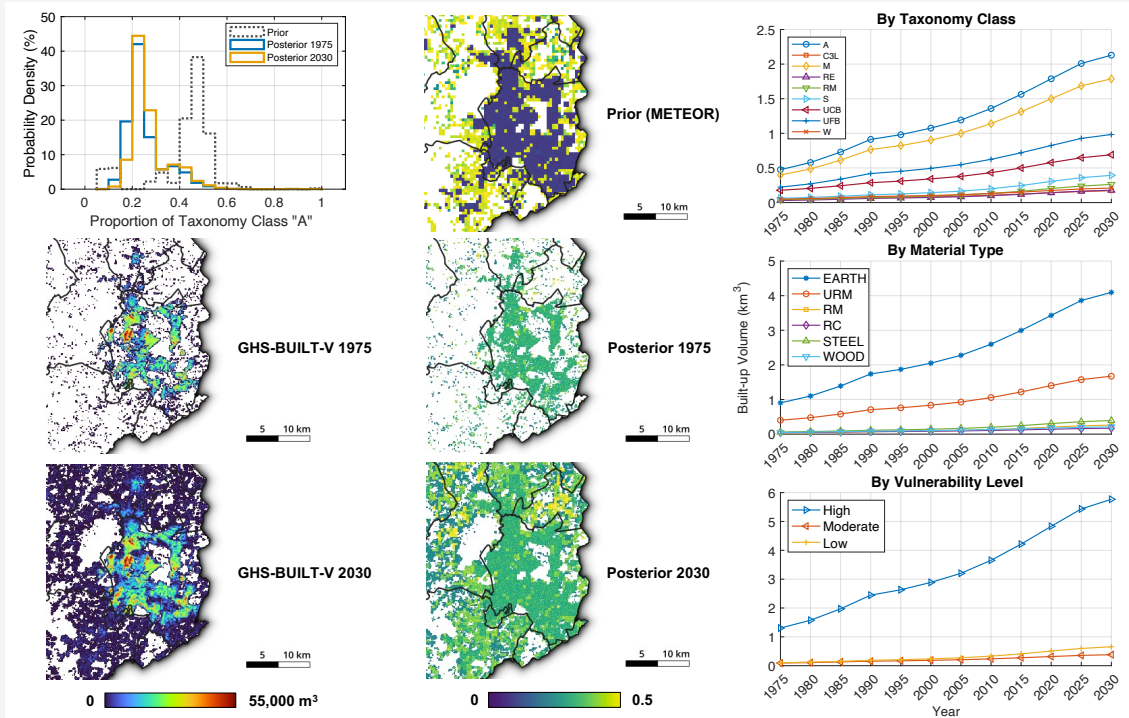
B.25 MOZ: Cidade Da Beira, Mozambique



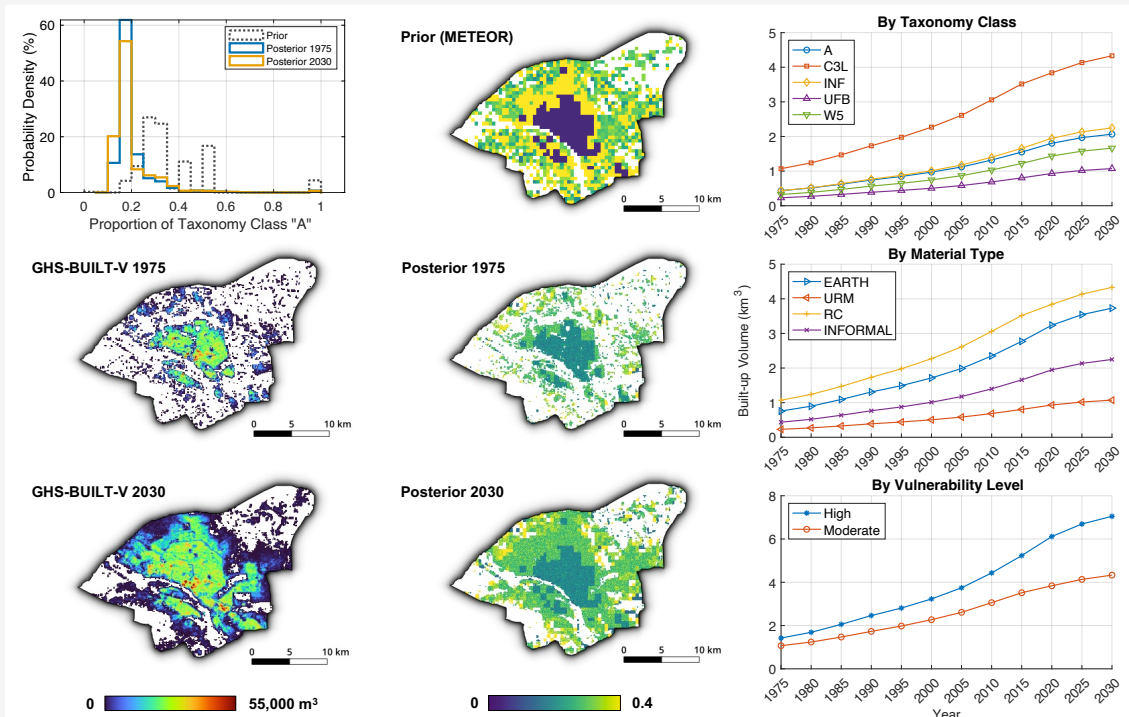
B.26 MRT: Nouakchott, Mauritania



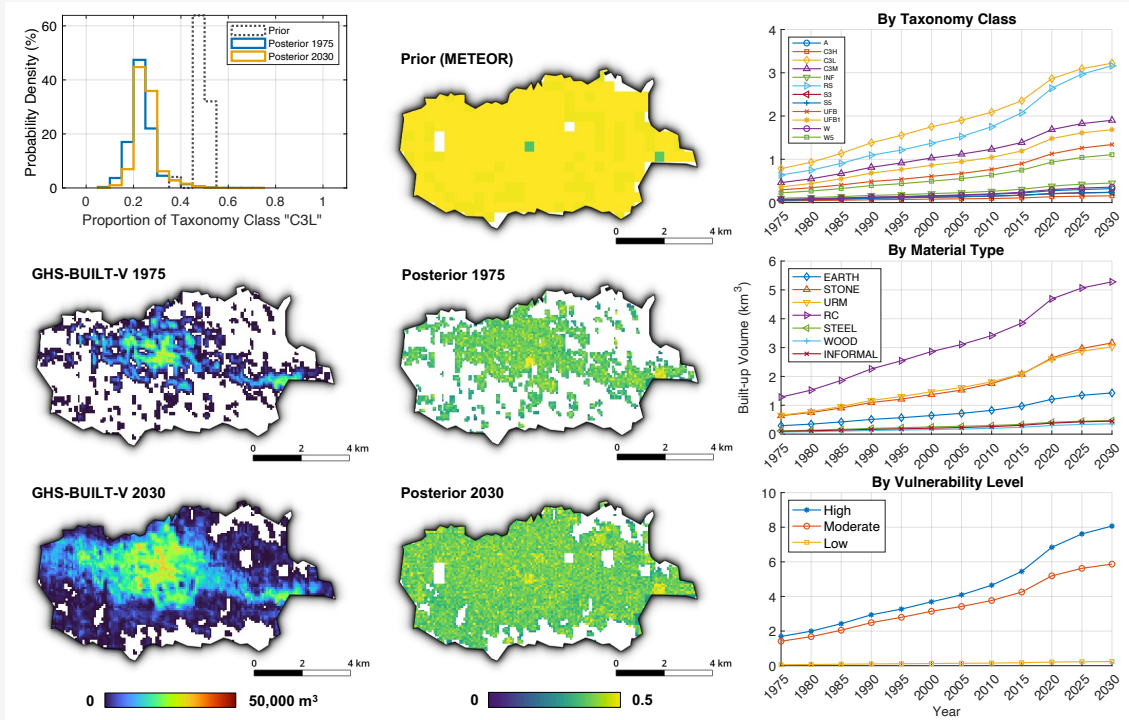
B.27 MWI: Blantyre, Malawi



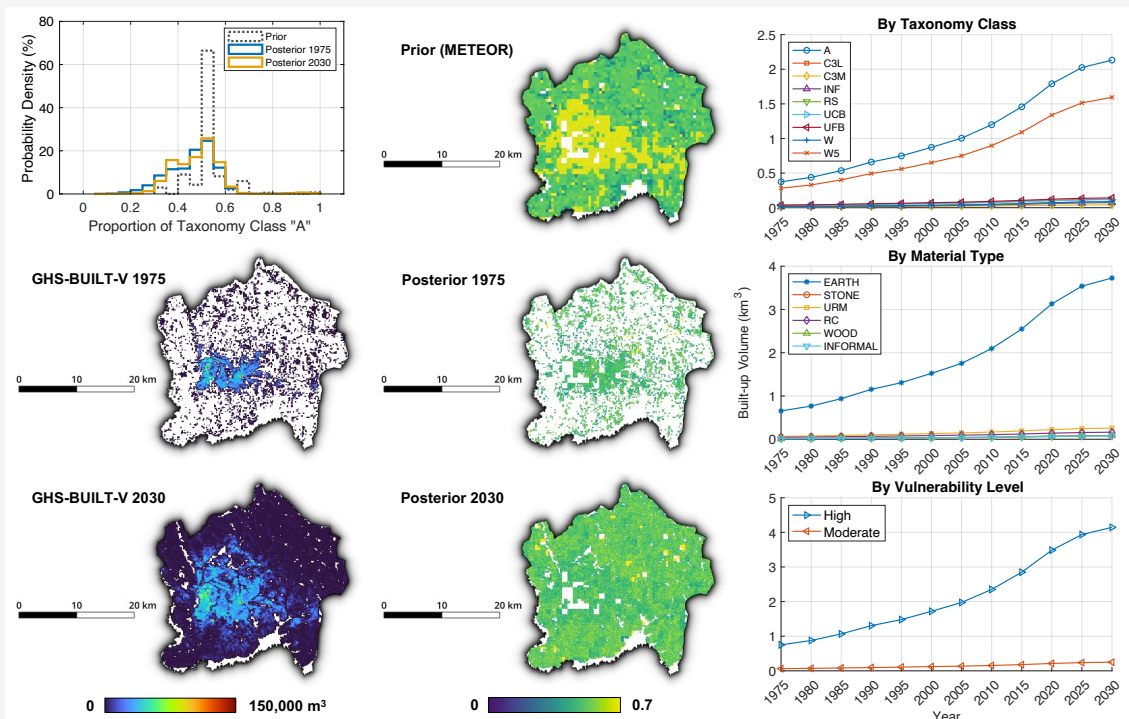
B.28 NER: Niamey, Niger



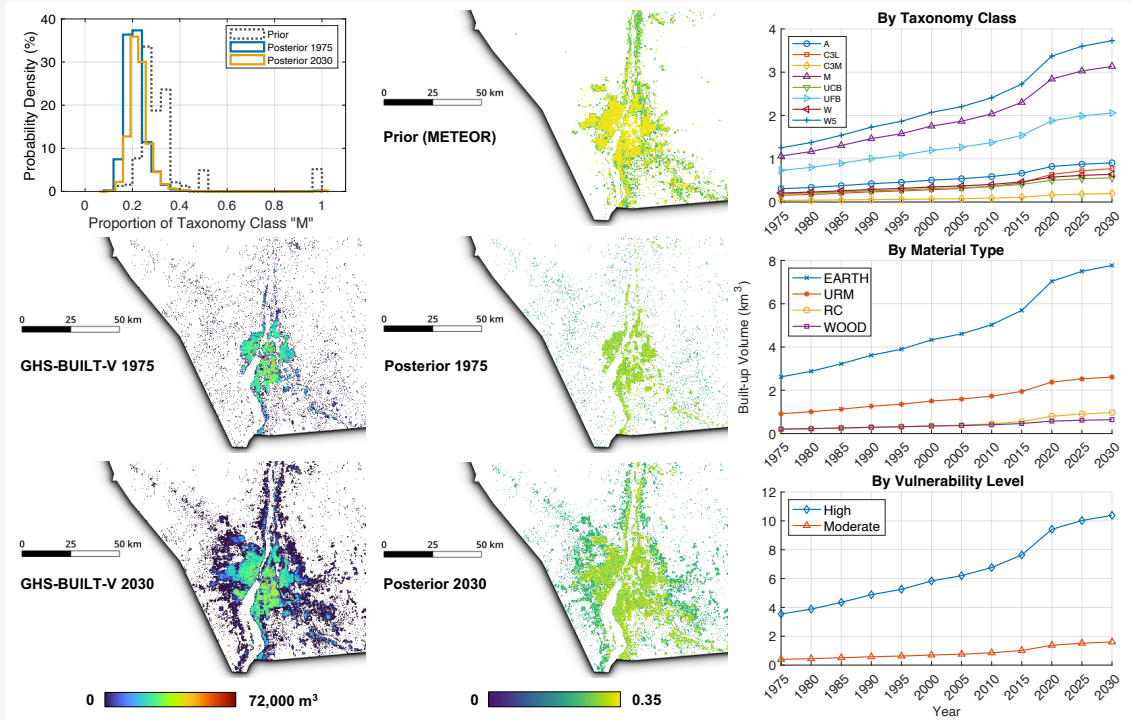
B.29 NPL: Biratnagar, Nepal



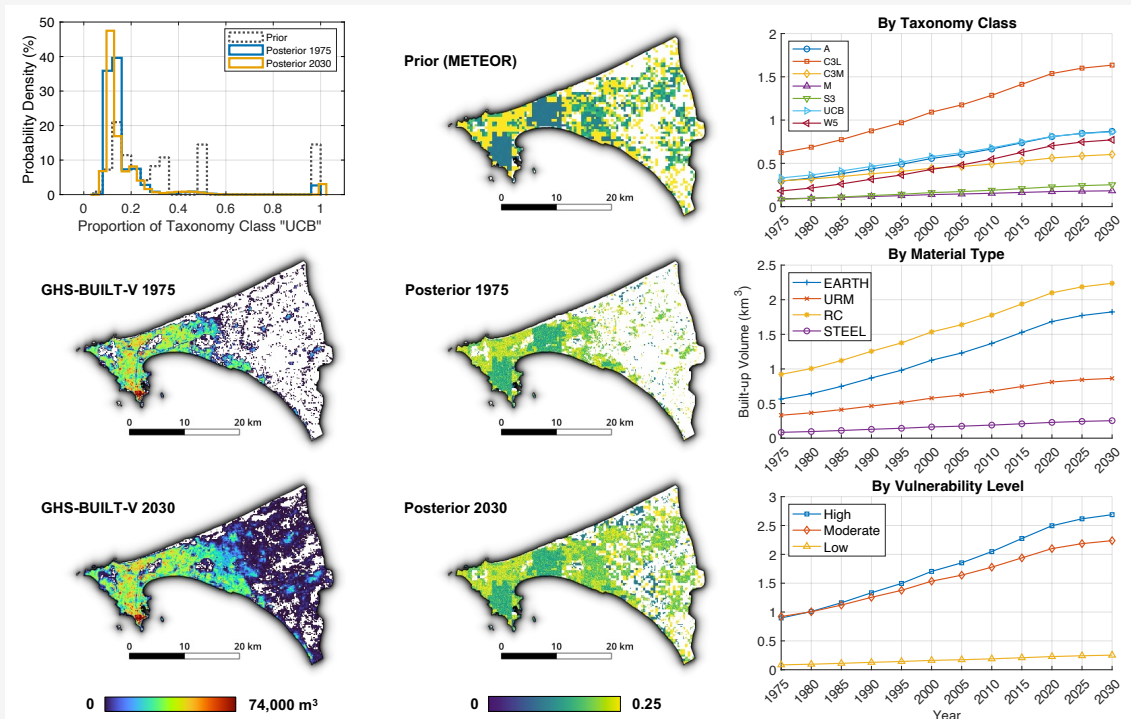
B.30 RWA: Kigali, Rwanda



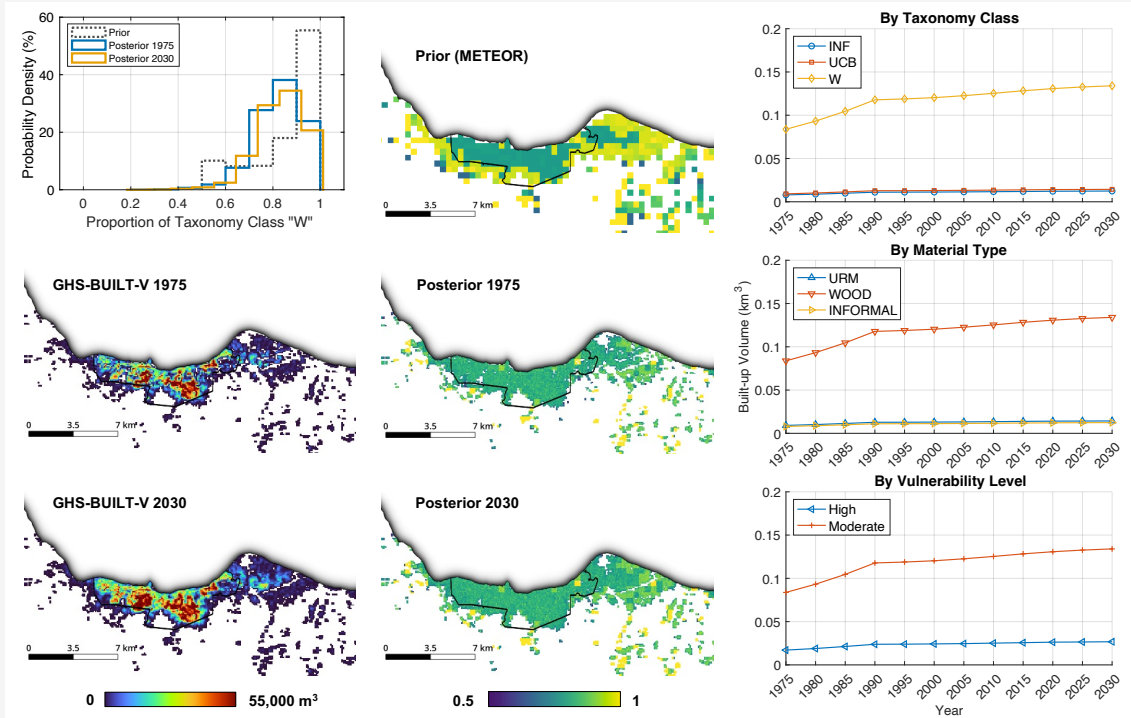
B.31 SDN: Khartoum, Sudan



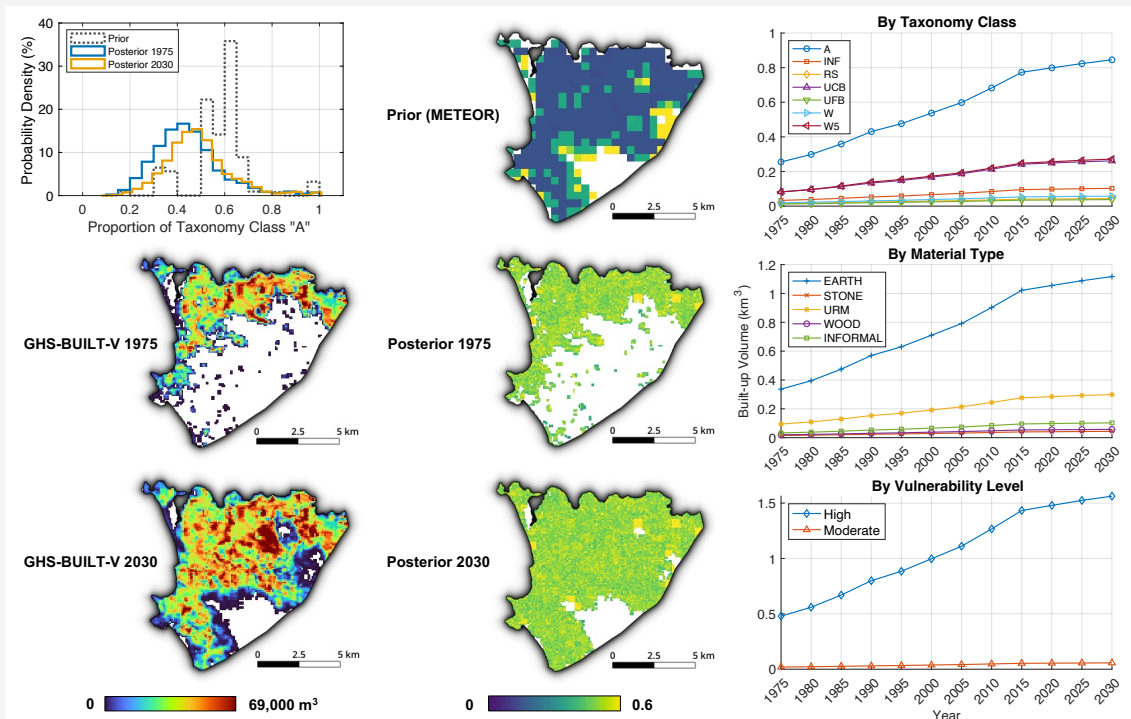
B.32 SEN: Dakar, Senegal



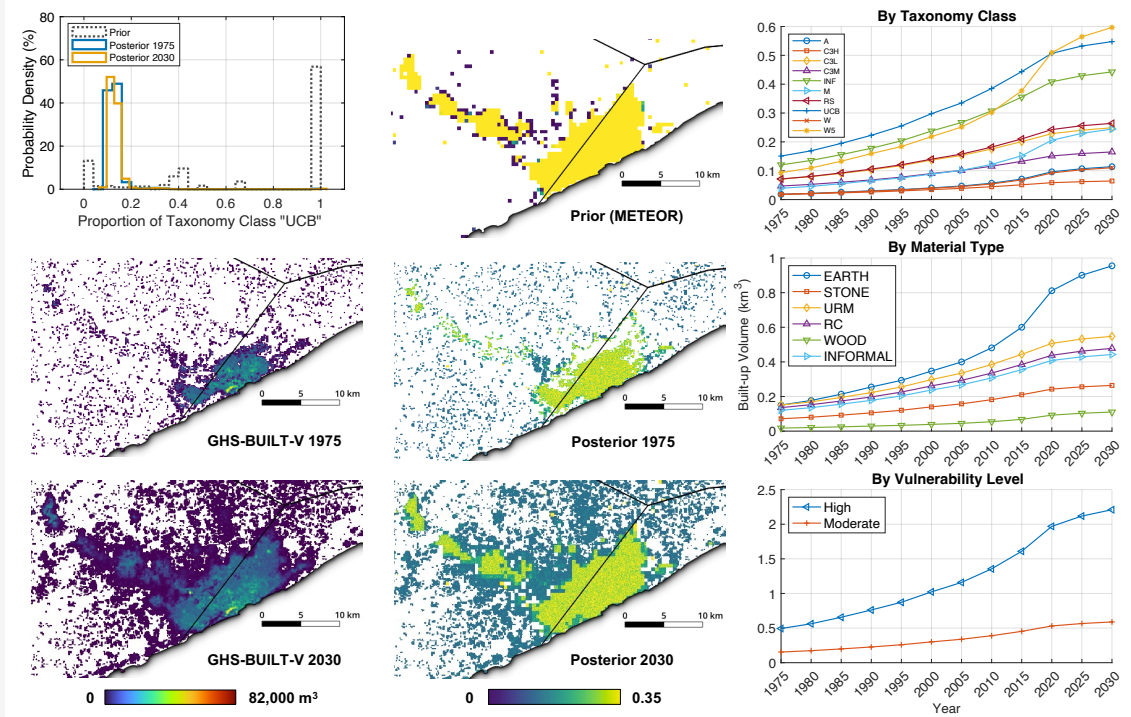
B.33 SLB: Honiara, Solomon Islands



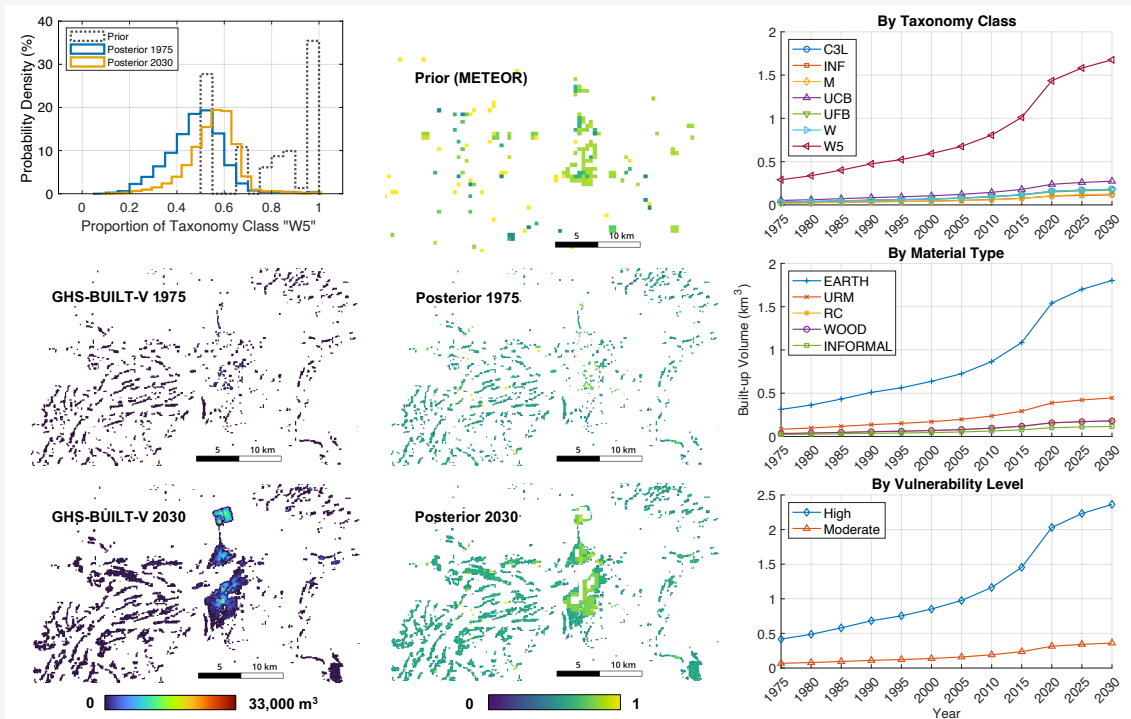
B.34 SLE: Freetown, Sierra Leone



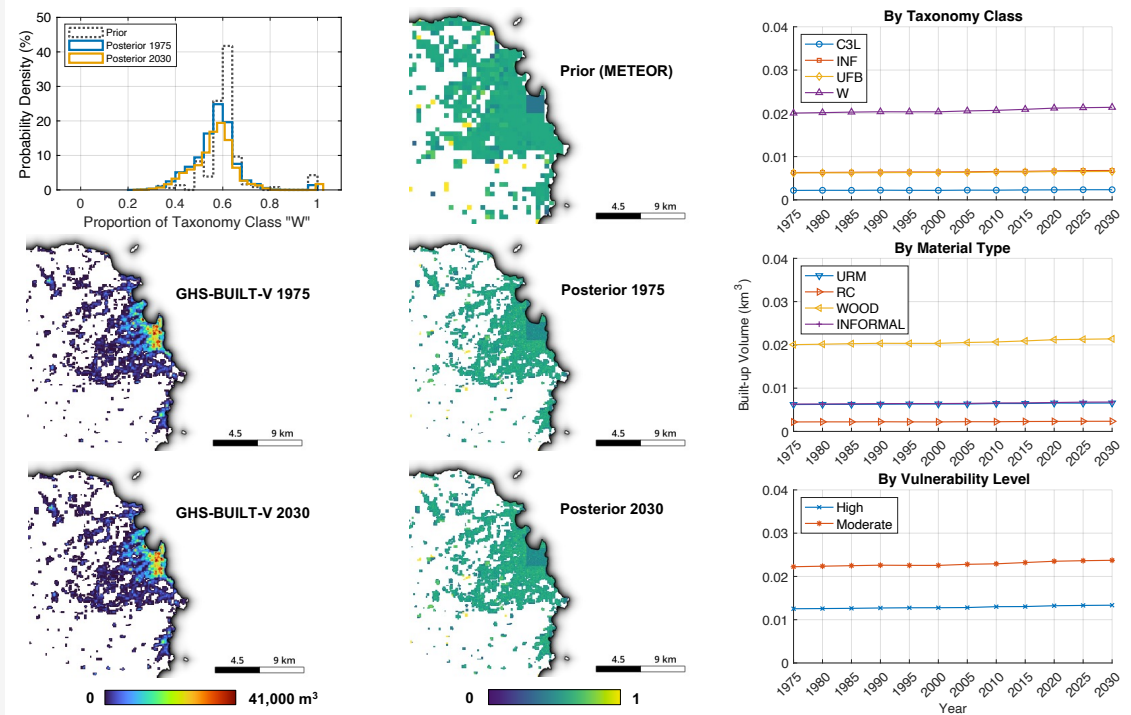
B.35 SOM: Mogadisho, Somalia



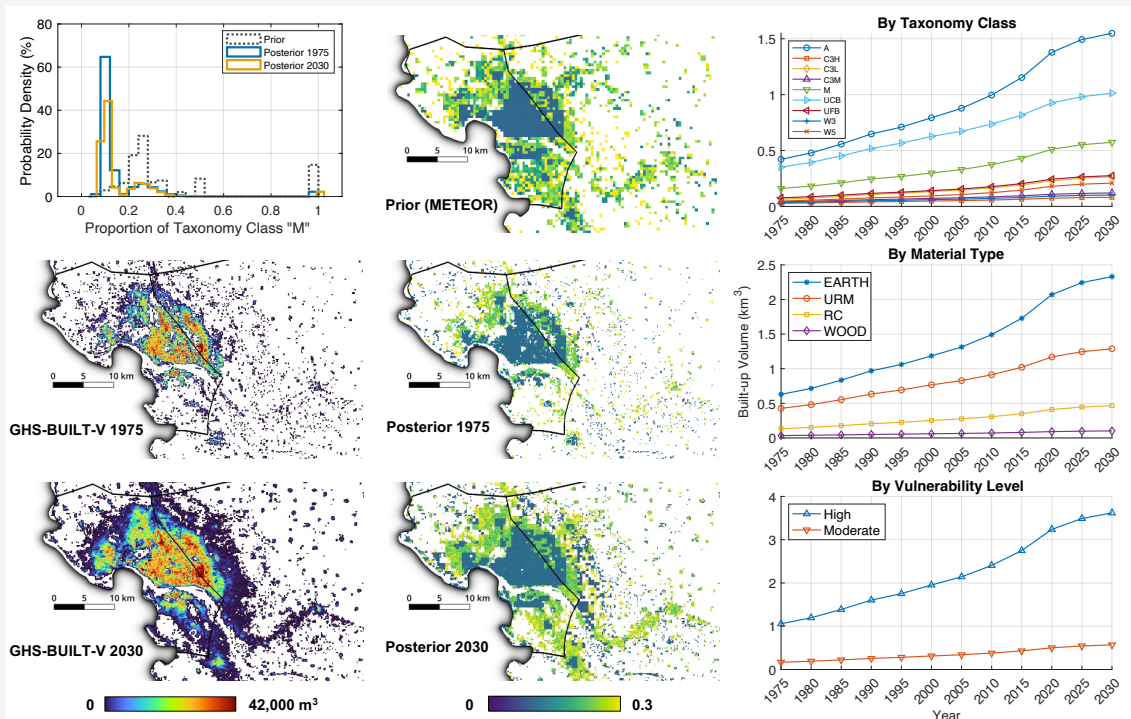
B.36 SSD: Bentiu, South Sudan



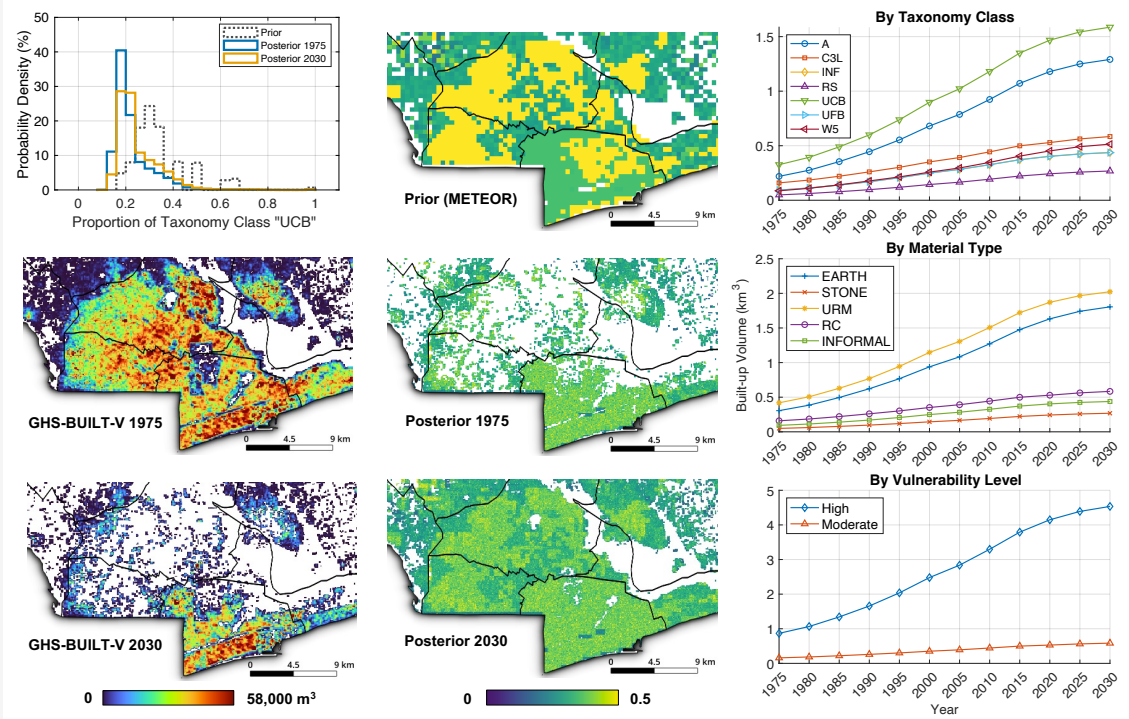
B.37 STP: Agua Grande, São Tomé and Príncipe



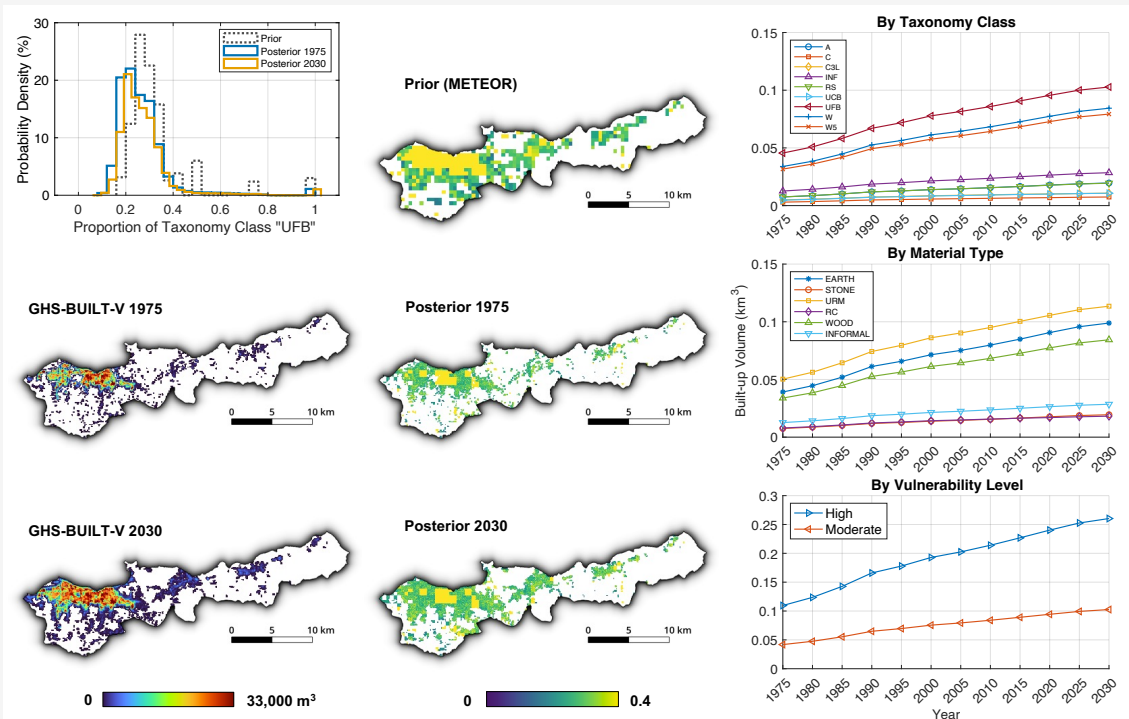
B.38 TCD: N'Djamena, Chad



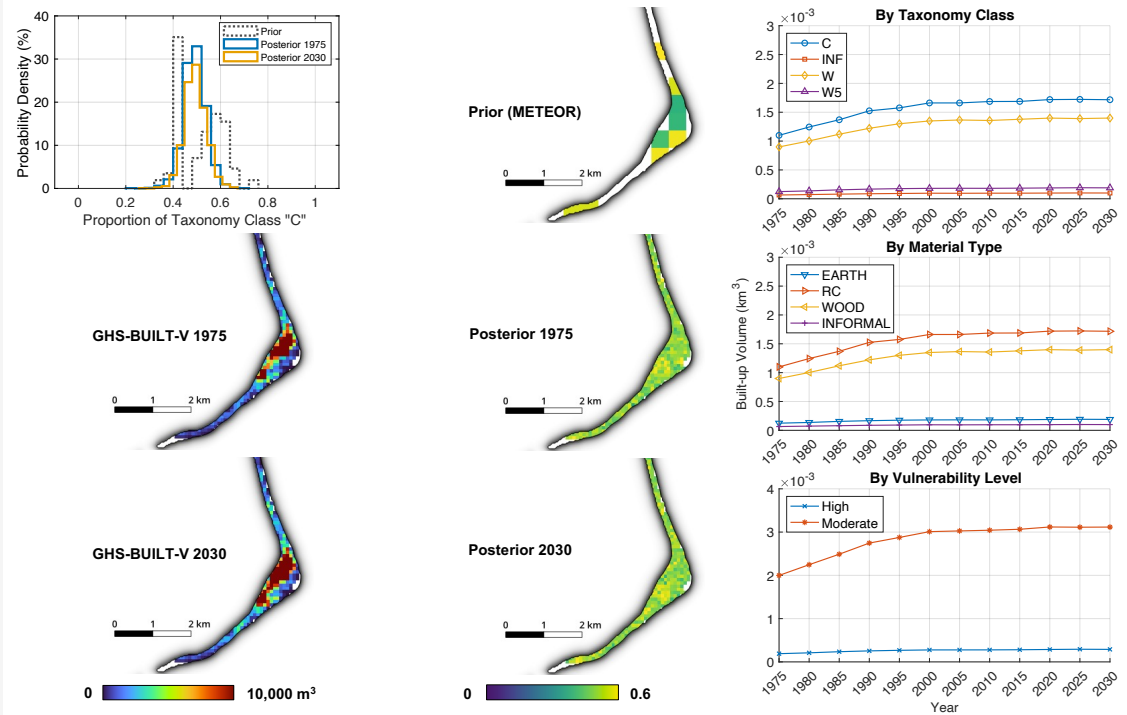
B.39 TGO: Lomé (and Neighboring Areas), Togo



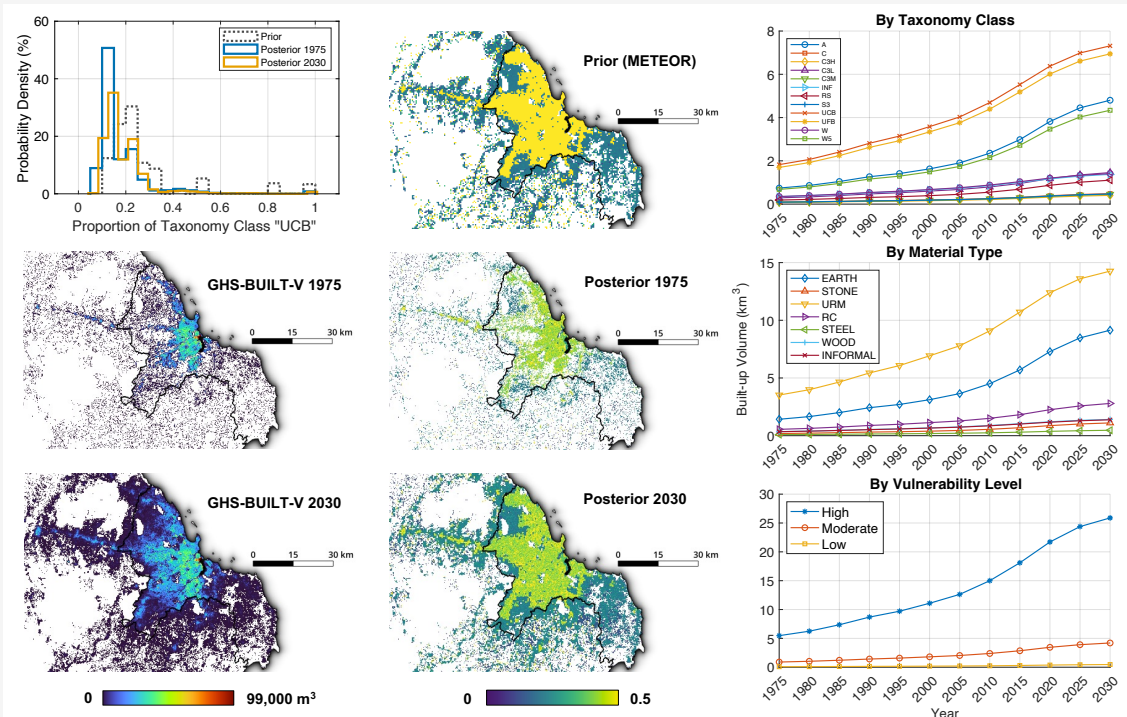
B.40 TLS: Dili, Timor-Leste



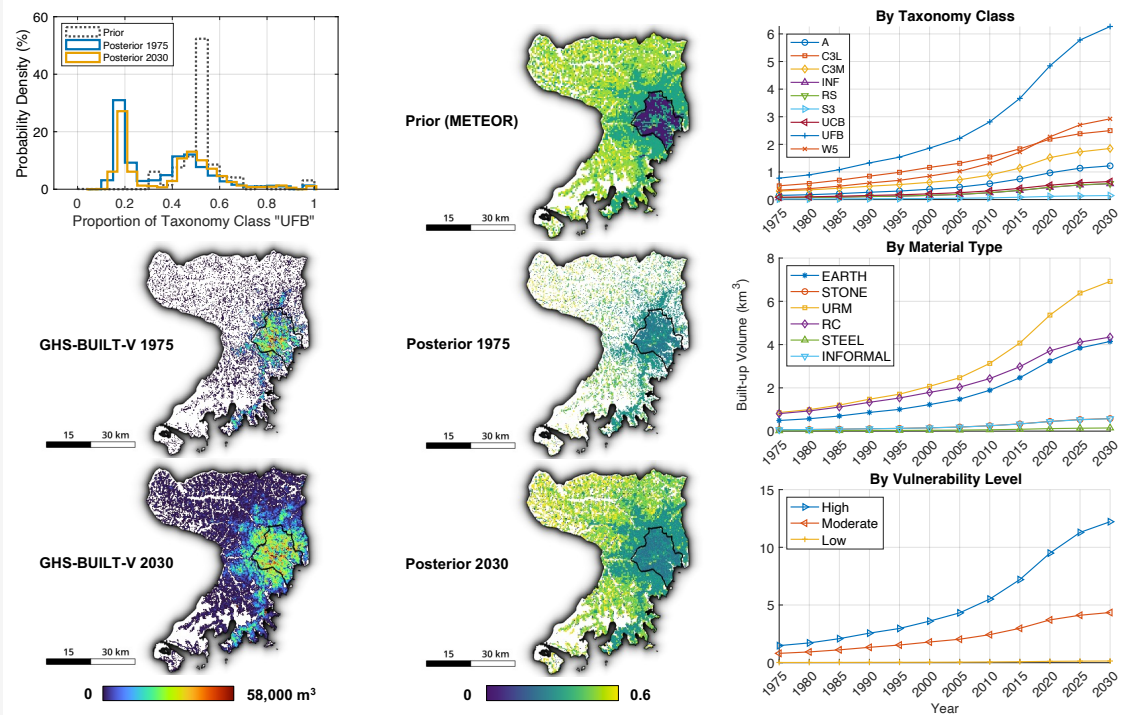
B.41 TUV: Funafuti, Tuvalu



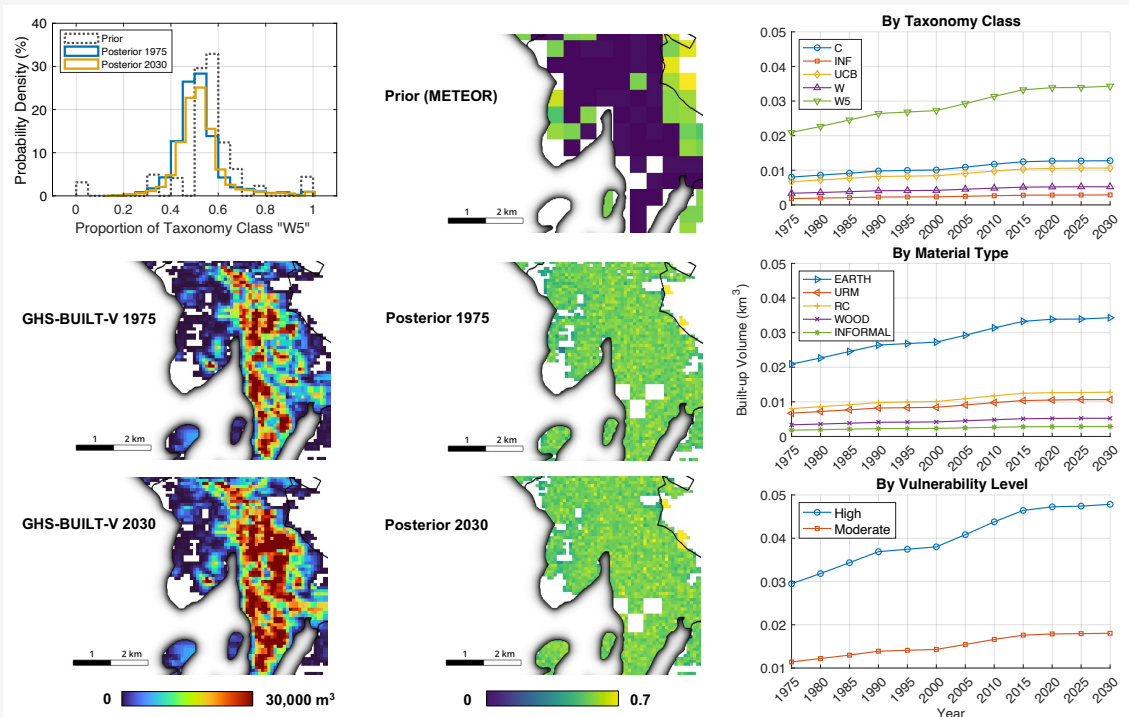
B.42 TZA: Dar es Salaam, Tanzania



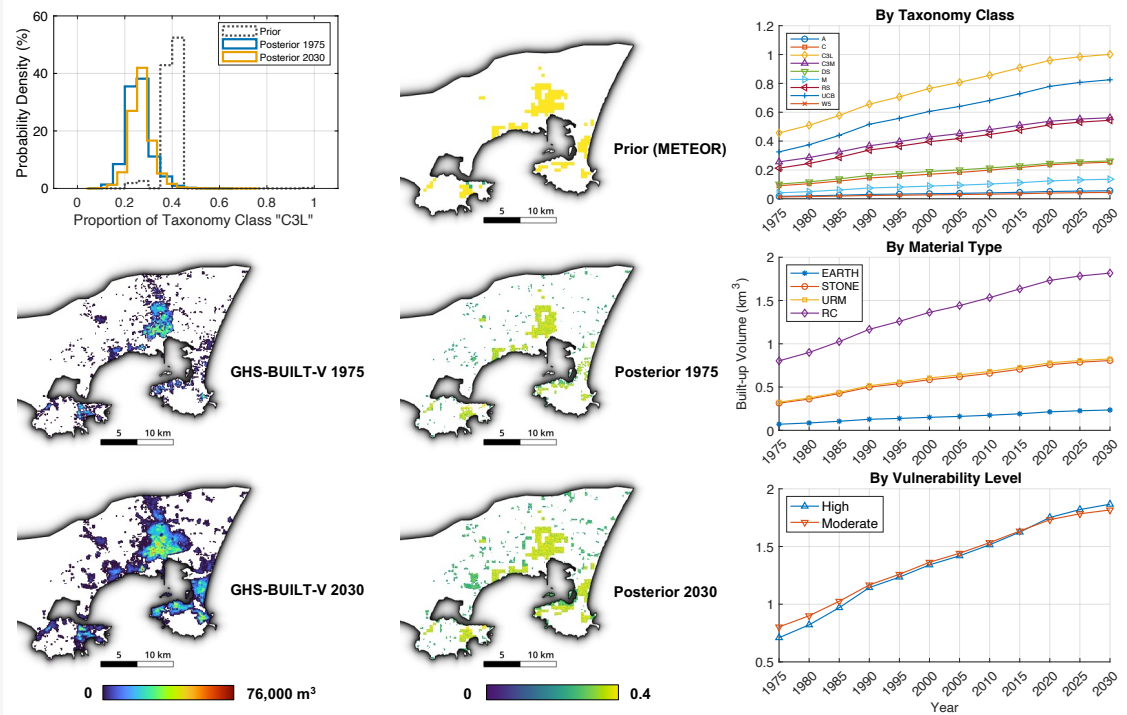
B.43 UGA: Kampala & Wakiso, Uganda



B.44 VUT: Port Vila, Vanuatu



B.45 YEM: Adan, Yemen



B.46 ZMB: Lusaka, Zambia

