

Desakota as Energy Potential Landscape: Distributed Hydropower Potential in the Taipei– Kaohsiung Mega Urban Region

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Asian urbanization has unsettled conventional urban/rural binaries, yet the infrastructural capacities of hybrid territories remain insufficiently examined. This paper reinterprets desakota as an energy landscape by assessing whether the Taipei–Kaohsiung Mega Urban Region offers favourable spatial preconditions for distributed low-head hydropower. Combining land-use co-presence, population density, hydrological networks, and electricity-grid data within a 5 × 5 km GIS framework, the study distinguishes desakota from predominantly urban and agricultural formations and compares their relative infrastructural characteristics. The findings show that desakota occupies approximately 29% of Taiwan’s inhabited land while accommodating about 42% of the national population. More significantly, it combines dense watercourse networks, comparatively strong electricity-network accessibility and carrying capacity, and a substantial dispersed demand base. These conditions differentiate desakota from compact urban cores, where water systems are often reduced or disconnected, and from lower-density agricultural areas, where grid capacity is weaker. The paper contributes to desakota studies by shifting attention from classification and transition to infrastructural potential, and to renewable-energy planning by demonstrating that feasibility is not only hydraulic or techno-economic but also territorial.

Keywords: *Desakota, energy landscape, distributed hydropower, low-head hydropower, Taipei–Kaohsiung Mega-Urban Region*

Introduction

The World Urbanization Prospects is recently shifting away from the dichotomy urban-rural to adopt a “degree of urbanization” perspective that treats landscapes as a continuum of urban, rural, and natural areas (UN 2025). This is highly relevant in Asia, where rural and urban activities very often coexist, and reinforces the need to revisit hybrid categories, such as the *desakota*.

It is long that McGee introduced this concept to describe the densely populated Asian territories where wet agriculture, settlement, manufacturing, and circulation networks are all enmeshed within extended metropolitan processes (McGee 1991, 2005). The concept emerged from research on urban geography categories such as the Extended Metropolitan Region, first, and the Mega Urban Region, later, and it has been influential in debates on Asian urbanization. Then, subsequent studies have progressively refined the concept as that of a mixed landscape characterized by the

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co-presence of wet-agriculture, structured water systems, high population densities, growing secondary activities, and high human connectivity (Wu and Sui 2016).

However, today, two interpretations are still in tension within the literature. One sees *desakota* as a transitional condition ultimately to be replaced by more conventional metropolitan forms, such as suburbanization. The other treats it as durable and thus distinctive spatial formation that needs ad-hoc planning. Relatively recent scholarship has strengthened this second view and argued that mixed agro-urban territories demand action-led, context-sensitive plans, rather than any imported blueprint planning (Chen et al. 2017).

However, the energy transition suggests a novel question that *desakota* literature has not yet addressed. This is whether the distributed morphology of *desakota* may be suitable for distributed renewable-energy systems and, in particular, to hydropower-based ones, given the diffuse and structured water systems of *desakota*. In this respect, it is important to mention how reviews have long shown that ultra-low-head technologies have expanded the range of possible applications (Elbatran et al. 2015, Butera and Balestra 2015, Zhou and Deng 2017) but grid connection remains a variable and, thus, the relation of generation sites, network accessibility, and demand is crucial (Forouzabakhsh et al. 2007). In other words, only when hydrological networks, electricity networks, and end-user demand are spatially interwoven—such as this appears to be in *desakota*—distributed hydropower energy systems may be plausible.

Consequently, the paper argues that *desakota* should be re-examined from this perspective. That is, rather than asking whether it is economically endogenous or morphologically transitional, it asks whether *desakota* is more favourable to distributed hydropower than adjacent territories. By this, the paper does not aim to claim the feasibility of any project but advances a morphological-comparative contribution to the literature.

Literature Review

Existing scholarship on *desakota* may be grouped into three strands. The first one is conceptual. McGee's original formulation described densely populated territories in which agriculture and non-agricultural employment coexisted to challenge the urban-rural binary inherited from Western theory (McGee 1991). Later, he also renewed the argument by insisting that Asian peri-urban regions have peculiar development pathways and cannot be reduced to suburbanization (McGee 2005). Research on rural urbanization and planning for the Asian Mega-City emphasized similar logics (Qadeer 2000, Yokohari et al. 2000) but recent studies have shown that, although the original concept is still valid, innovations had happened. Indeed, if some territories keep displaying stable *desakota* characteristics, others have undergone a restructuring that exceeds the original formulation of the concept (Hong and Kim 2023).

Anyhow, recent scholarship uses it to question “city-centred” accounts of various processes. E.g., Ortega's “*desakota 2.0*” has situated hybrid territories within postcolonial debate, insisting that these must be read through local histories and socio-spatial dynamics rather than any alterity to a supposed normal metropolitan fringe. Gillen, Bunnell, and Rigg's “*rural-ization*” has displaced the assumption that urbanization proceeds through the disappearance of the rural, arguing that it is a

balance with the urban to be at stake. Recent work on the “*peri-urban turn*” and landscape-based planning reinforces this understanding by treating the urban-rural interface as a complex socio-ecological *milieu*, rather than a transitional arrangement (Ortega 2020, Gillen et al. 2022, Rajendran et al. 2024, Tan et al. 2024).

A second strand of research focuses on empirical-operational measurements. In this framework, Shih and Chi (2012) showcased how *desakota* is best understood not as a residual category between city and countryside but as an actively contested space. Wu and Sui (2016) further clarified how the growth of *desakota* can be related to globalization and, in particular, the expansion of foreign direct investment and service economy. However, regardless such studies moved the discussion to aspects of spatial form, they remain primarily concerned with classification.

A complementary empirical strand has translated *desakota* in terms of remote-sensing and, from this, brought the concept in contact with associated studies. E.g., Sui and Zeng (2001) used landscape indexes and cellular automata to model landscape dynamics in Shenzhen, and Xie et al. (2006, 2007) similarly examined emergent *desakota* in Suzhou. Work on Ho Chi Minh and Jabodetabek extended the approach to peri-urban population growth and the changing economic, social, and ecological role of agriculture (Kontgis et al. 2014, Pribadi and Pauleit 2015). Recent work continues the trajectory: e.g., Ge et al. (2026) developed a population-land-transport framework for urban-rural integration in Jiangsu based on *desakota* metrics. If these studies expand the empirical vocabulary of *desakota*, at the same time they reveal a methodological asymmetry. Land cover, density, accessibility, and other administrative categories are often operationalized, but infrastructure, including irrigation, drainage, and energy systems remain relatively untouched.

A third strand addresses governance. Long ago, Dick and Rimmer (1998) already argued that the changing geography of Asian urbanization, here including *desakota*, could no longer be explained by Third World city models. More recently, Chen et al. (2017) has showed that conventional planning mismatches mixed landscapes, such as the *desakota*, and, in particular, their spontaneous investment patterns. Across such a literature, *desakota* tends to appear as a planning challenge or a transitional formation. What remains less developed is a reading of *desakota* as a spatial arrangement that helps or condition the development and later management of infrastructure within.

Governance literature also connects to ecosystem services and resource management discussions. E.g., Moench and Gyawali (2008) interpret *desakota* as an interconnected rural and urban livelihood, rather than an administrative category alone. Their seminal study shows that household strategies and environmental pressures traverse the rural/urban divide, and that a singular territory may be exposed to agricultural, industrial, residential, and infrastructural demands simultaneously. From this point of view, *desakota* is difficult not only because morphologically mixed. It is also because water, energy, and mobility systems within are institutionally fragmented but materially interlinked, a condition that strengthens the argument for reading *desakota* as an infrastructural landscape.

The underlying knowledge gap becomes more evident when it comes to energy. If it is a decade since reviews have shown how technological development widened the range of hydraulic conditions under which distributed generation can

be considered, including aspects of turbine types, civil works, and generator configurations, studies of irrigation networks have also shown that canals, drops, and hydraulic control structures may be treated as latent energy sites rather than just as water-conveyance devices (Carravetta et al. 2012, Williamson et al. 2014, Quaranta and Revelli 2018). More recently, reviews have also extended this agenda by comparing costs and performance across the technologies (Klein and Fox 2022, Duah et al. 2026, Chernobrova et al. 2026). Yet the literature remains very often site-technical or techno-economic. It rarely asks which forms of urbanization produce and maintain a spatial conjunction of hydraulic potential, electricity demand, and distribution infrastructure adequate for the diffuse adoption of hydropower, not to mention the relations with *desakota*.

In summary, the scholarship has examined *desakota* in terms of socio-economic transition, land-use change, governance, and environmental conflict, but far less attention has been given to the ways in which its irrigation networks, dispersed settlement, and electricity distribution infrastructures may constitute the possibility for a distinctive energy landscape. However, taken as a whole, the literature also suggests that *desakota* may be approached as a socio-eco-infrastructure formation, not only as a land-use mixture or planning anomaly. Indeed, some of its key features seem to create an opportunity field for distributed low-head hydropower that differs from the development potentials of any urban core or agricultural hinterland.

So, this paper aims to contribute to *desakota* studies by shifting the focus from classification to infrastructural capacity, and to renewable energy studies by addressing how systems feasibility may not only be techno-economic, but also territorial. Specifically, the paper asks whether *desakota* can provide spatial preconditions for distributed low-head hydropower that are more advantageous than those of urban cores or agricultural hinterlands within the same Mega Urban Region.

Contribution and Structure of the Paper

In Taiwan, *desakota* has been examined in both metropolitan and county-scale studies (Liu and Tsai 1991, Shih and Chi 2012, Wu and Sui 2016). So, the paper investigates the Taipei–Kaohsiung Mega Urban Region as a pertinent case through which to test the relation between urban form and distributed low-head hydropower potential. The research classifies this Mega Urban Region into various broad territorial formations—including *desakota*, predominantly agricultural areas, and more conventional urban areas—on the basis of land-use co-presence and population density. It then compares these formations in terms of watercourse density, electricity-network accessibility and carrying capacity, and spatial distribution of population. The aim is to determine whether *desakota* presents more favourable spatial preconditions for distributed generation than the other formations. The study is conceived as a regional screening and comparative analysis; as such, it does not replace hydrological modelling, ecological assessment, or plant-level techno-economic feasibility studies.

The paper is organized in five parts. After the introduction, Section 2 defines the case study and the analytic model. Section 3 presents the results of the study, first by identifying the distribution of different urban forms within the Taipei–Kaohsiung Mega Urban Region and then comparing those forms in relation to

hydrological and electrical networks. Section 4 discusses the implications of the findings in terms of *desakota* interpretation and outlines the limitations of the study. Then, Section 5 concludes by summarizing the contribution and indicating directions for future research.

Materials and Methods

Case Study

In the wider literature on Asian urbanization, Taiwan has often been treated as an exemplary case of dispersed industrialization, intensive infrastructural development, and persistence of agriculture amid metropolitan change (Liu and Tsai 1991, Williams 1998, Wu and Sui 2016), here including the seminal study by McGee (1991). Also, the Taipei–Kaohsiung Mega Urban Region is relevant for the discussion since, starting in 2019, the planning frameworks of Taiwan explicitly recognize urban-rural development as a distinct field of spatial governance. This does not in itself validate the study on *desakota*, but it adds practical relevance of analyzing mixed territories within the context of the case study.

Taiwan's western plain not only concentrate most of the urbanizable land of the island but also corresponds to the space of the Mega Urban Region. This has developed over long time through the interaction of irrigated agriculture, transport infrastructure, and industrialization. Wet-rice cultivation and irrigation systems have expanded historically, while twentieth-century investments and public works progressively consolidated a dense territorial infrastructure. Then, after World War II, land reform, export-oriented industrialization, and rural electrification accelerated the diffusion of small and medium enterprises. Altogether, rather than producing a centralized metropolitan system, these processes have generated a highly interwoven urban-rural territory where industry, housing, mobility networks, and agricultural land are closely articulated.

Analytic Model

The research is based on publicly accessible data retrieved from public institutions and utility sources, retrieved in geospatial format and structured into a coherent database. These data included topographic data from 2016, obtained from the National Land Surveying and Mapping Center, Ministry of the Interior, population data from 2018, acquired from the Directorate General of Budget, Accounting and Statistics, the Executive Yuan, land use data from 2017, sourced from the National Land Surveying and Mapping Center, Ministry of the Interior, water stream data from 2020, provided by the Water Resources Agency, Ministry of Economic Affairs, and then power grid data from 2019, provided by Taiwan Power Company. Census data were integrated from the smallest available administrative units, about 3,000 people big.

The analysis proceeded in four steps. First, urban and rural land uses and population density were assessed in order to distinguish territorial formations based on density and land use copresence. Second, the total length of watercourses—

natural, regulated, and constructed—was calculated as a proxy for opportunities for low-head hydropower generation. Third, the presence of waterdrops was assessed through GIS computing by integrating the location of watercourses with topographic data, road network, and land subdivision, the parcels of public land within 5 m from a road and holding a water drop being understood as units of intervention for the possible implementation of hydropower. Important to remember, these occurrences of waterdrops should anyway be understood as candidate spatial conditions rather than actual hydropower sites. Fourth, the electricity network was assessed in terms of spatial coverage and available carrying capacity as a proxy for connection potential.

To operationalize land-use co-presence, all relevant layers were assigned to a 5×5 km grid aligned with the National Topographic Survey framework. Urban and rural land-use patches were then buffered at 150, 200, 300, 500, 850, and 1,200 m. The buffered areas were rasterized to a 1×1 m grid, after which the percentage of each 5×5 km cell situated within the specified proximity to both urban and rural land-use patches was calculated. The 200 m and 850 m outputs were then used for the later research development purposes since they could better differentiate fine-grained mixed landscapes from broader mixed territorial zones.

Population density was projected onto the same 5×5 km grid and used together with the co-presence analysis. In line with the comparative literature on *desakota* and high-density rural urbanization, cells with more than 1,000 inhabitants/km² were treated as exceeding a suburban threshold and therefore as potentially pertinent to *desakota* when associated with strong urban-rural co-presence (Qadeer 2000). Cells with more than 1,000 inhabitants/km² but lack of urban-rural co-presence were considered suburban. Cells with more than 5,000 inhabitants/km² were considered fully urban, and cells with less than 1,000 inhabitants/km² were considered rural or wild.

Results

Spatial Distribution of Different Urban Forms within the Taipei–Kaohsiung Mega Urban Region

The 850 m assessment identifies a relatively compact area with more than 70% urban-rural co-presence. Its outer limit broadly follows the change in topography between the western plain and the foothill zone. By contrast, the 200 m assessment reveals a finer-grained and more discontinuous “filament” extending from the periphery of Taipei to Kaohsiung, interrupted by major rivers and their floodplains.

Within this finer-grained assessment, the 70% copresence ratio constitutes a threshold within the distribution of values and can therefore be interpreted as marking the transition to the more intense urban-rural mix. When this threshold is combined with the population criterion of more than 1,000 inhabitants/km², the resulting area is classified as *desakota*.

According to the analysis, *desakota* occupies 7.8% of Taiwan’s island area, or approximately 29% of its inhabited land, and contains 9.84 million inhabitants, roughly 42% of Taiwan’s total population. According to the statistic structure of the

study, about 89% of this population is expected to live within 200 m of both an urban and a rural land-use patch (see Figures 1-3).

Relation between Urban Forms, Hydrologic, and Electric Networks

For the hydrological and electricity-network assessment, five territorial frames of analysis were compared: (1) the whole territory; (2) the area defined by cells with more than 70% urban–rural co-presence in the 850 m assessment; (3) the area defined by cells with more than 70% co-presence in the 200 m assessment; (4) the area defined by cells classified as *desakota*; and (5) the area defined by cells classified as urban. The 5×5 km cell structure remains the common unit of analysis to define the frames and to assess the hydrological and electrical data within (see Figures 4-7). Because cumulative comparisons between nested frames could conceal the characteristics of the areas added or excluded at each stage, non-overlapping areas between frames were also assessed. Through this approach, the assessment identifies how conditions change as the analysis moves toward increasingly fine-grained and densely inhabited urban–rural formations (see Table 1).

Figure 1. *Taiwan Island's Population Density and Urban Areas Distribution*

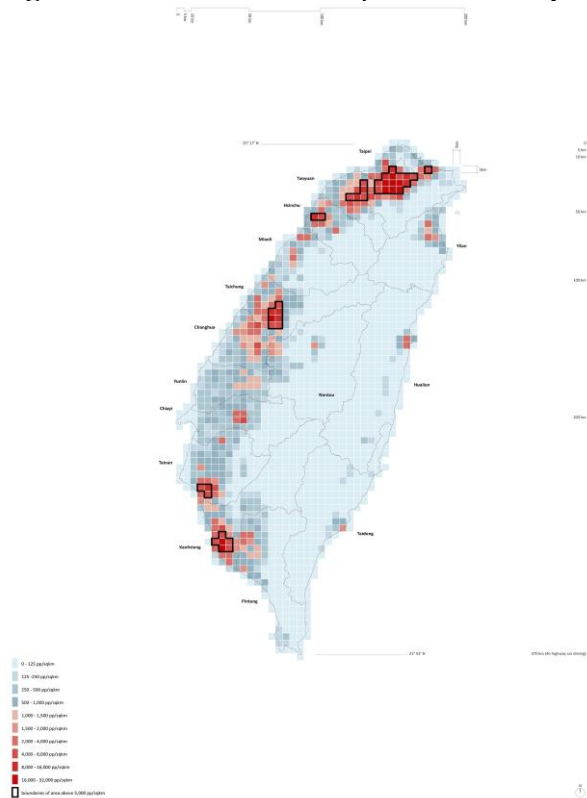


Figure 2. 850 m Buffer Urban-Rural Land Use Copresence Distribution

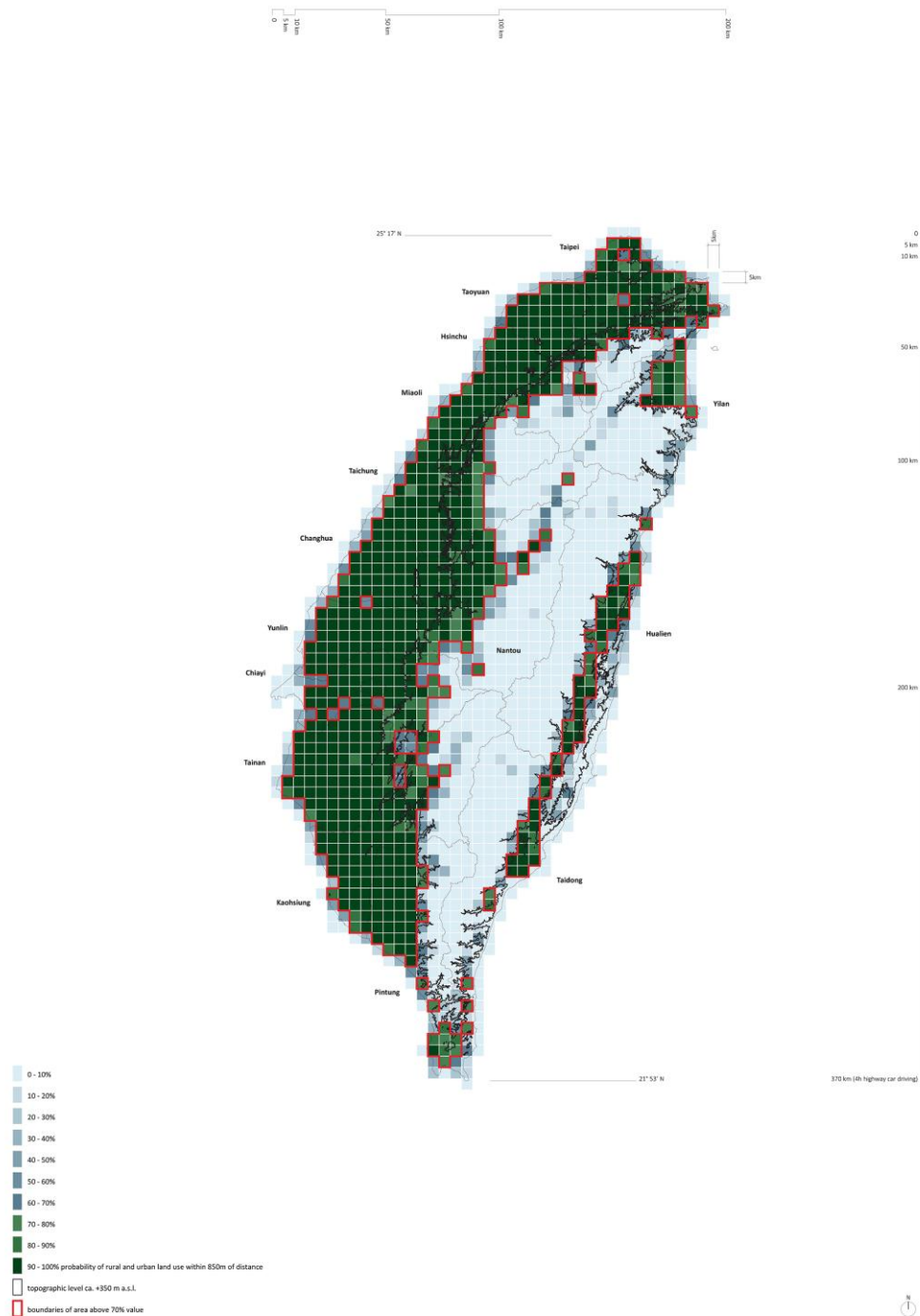


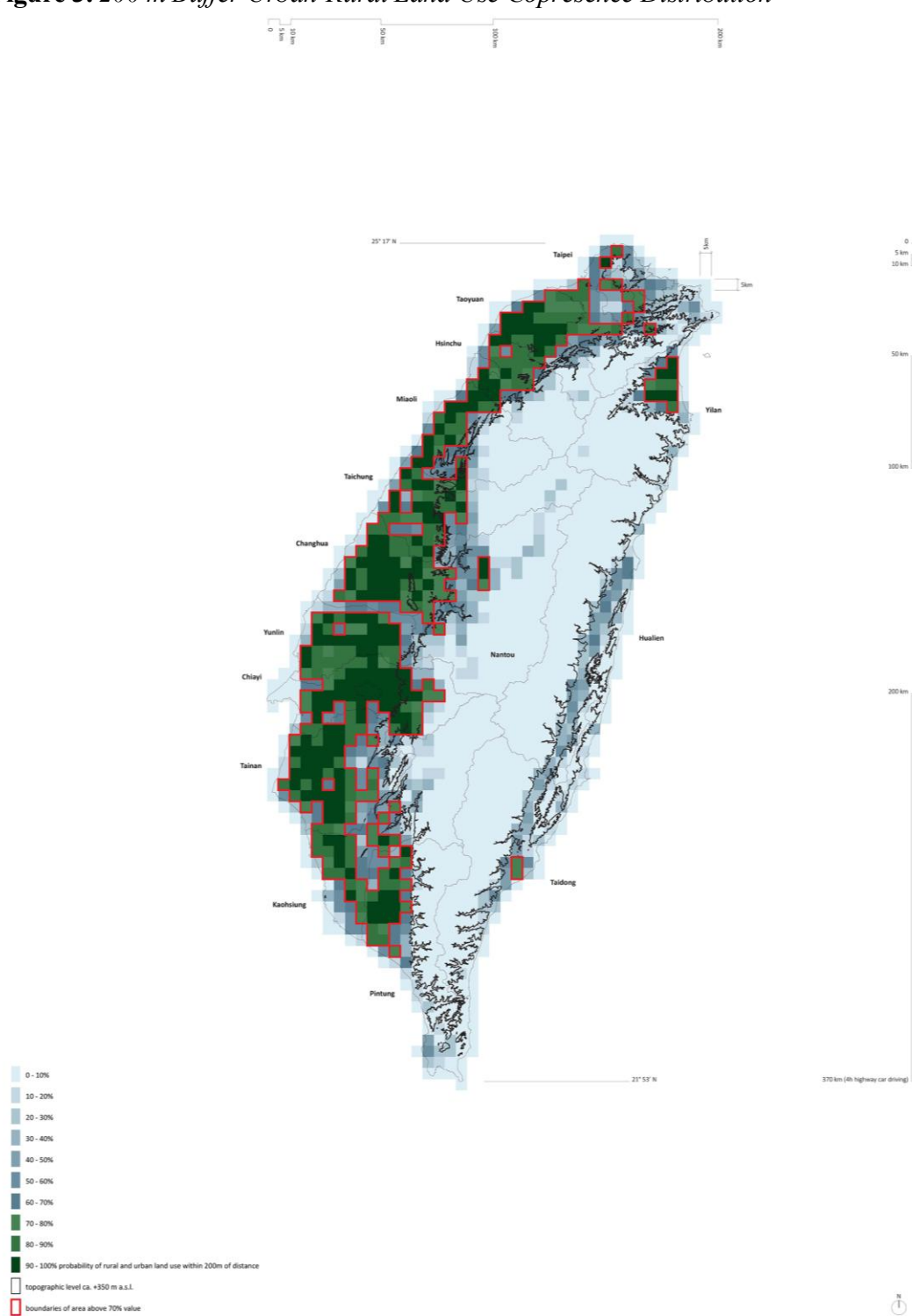
Figure 3. 200 m Buffer Urban-Rural Land Use Copresence Distribution

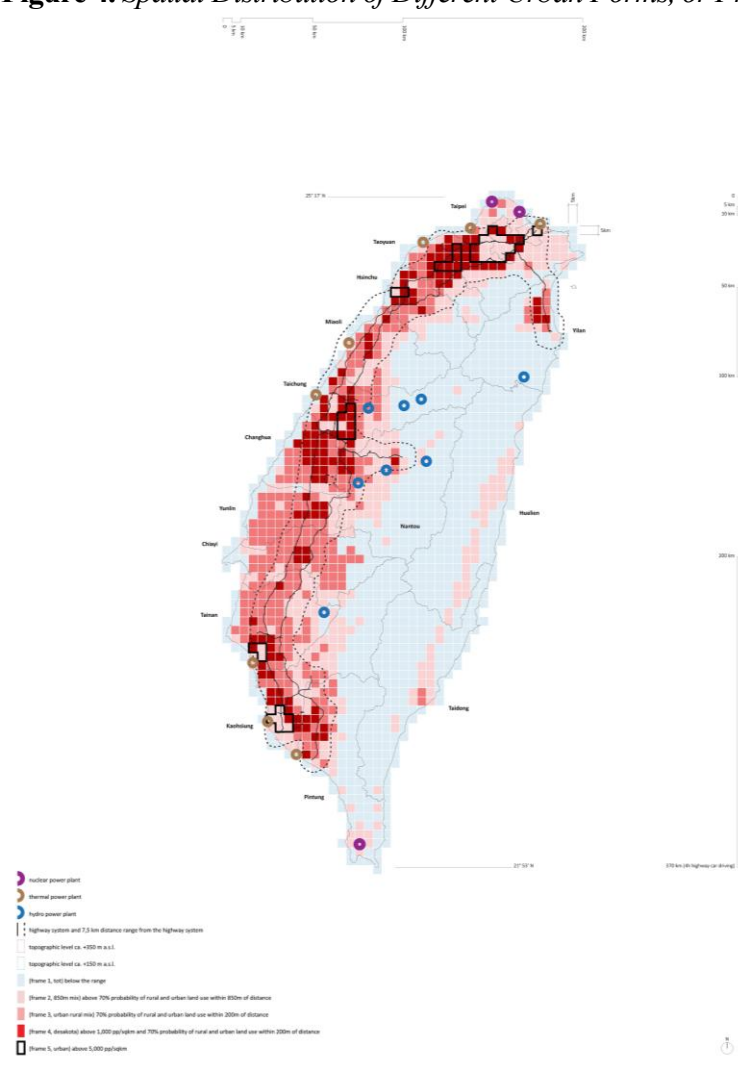
Figure 4. *Spatial Distribution of Different Urban Forms, or Frames of Analysis Map*

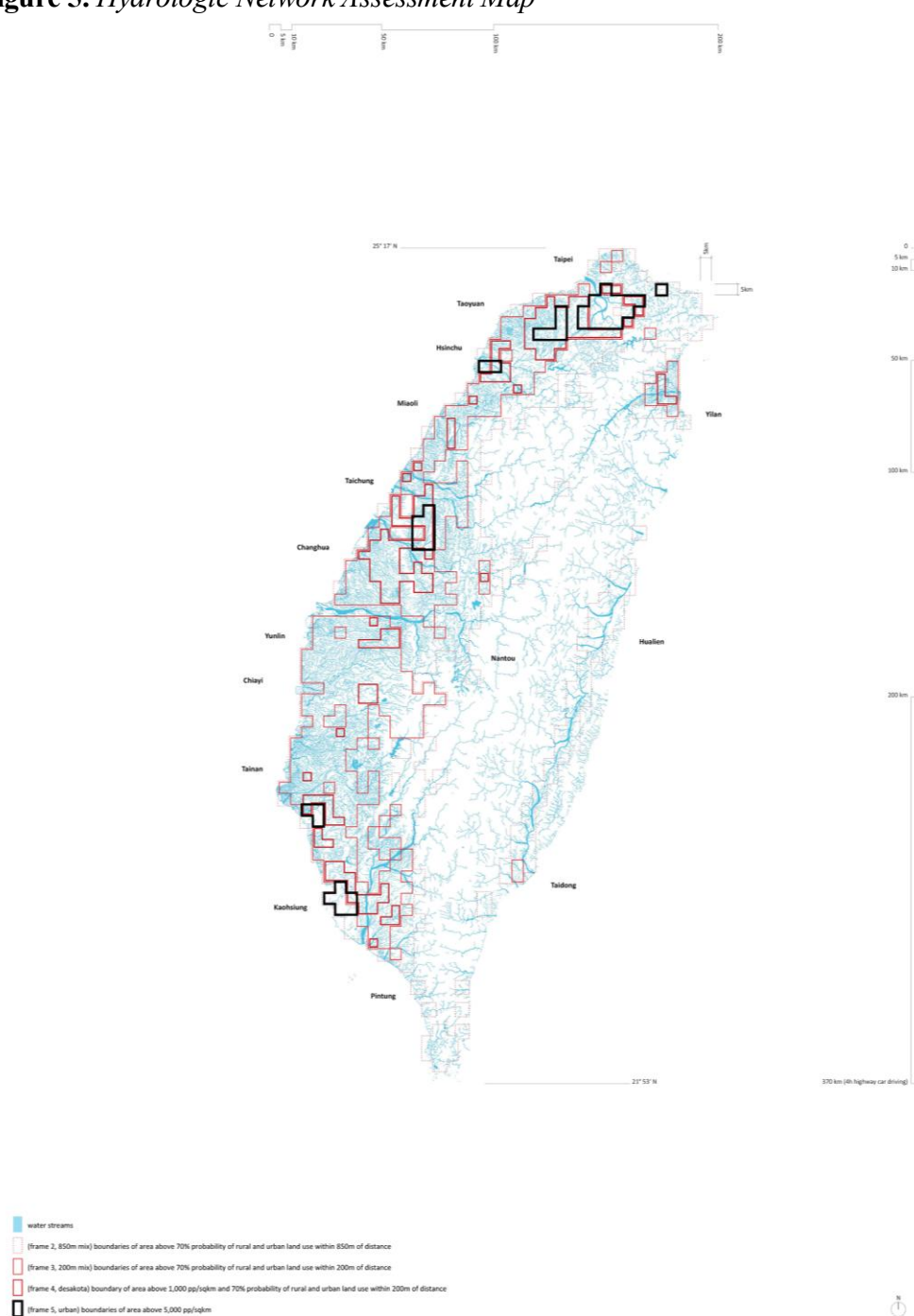
Figure 5. Hydrologic Network Assessment Map

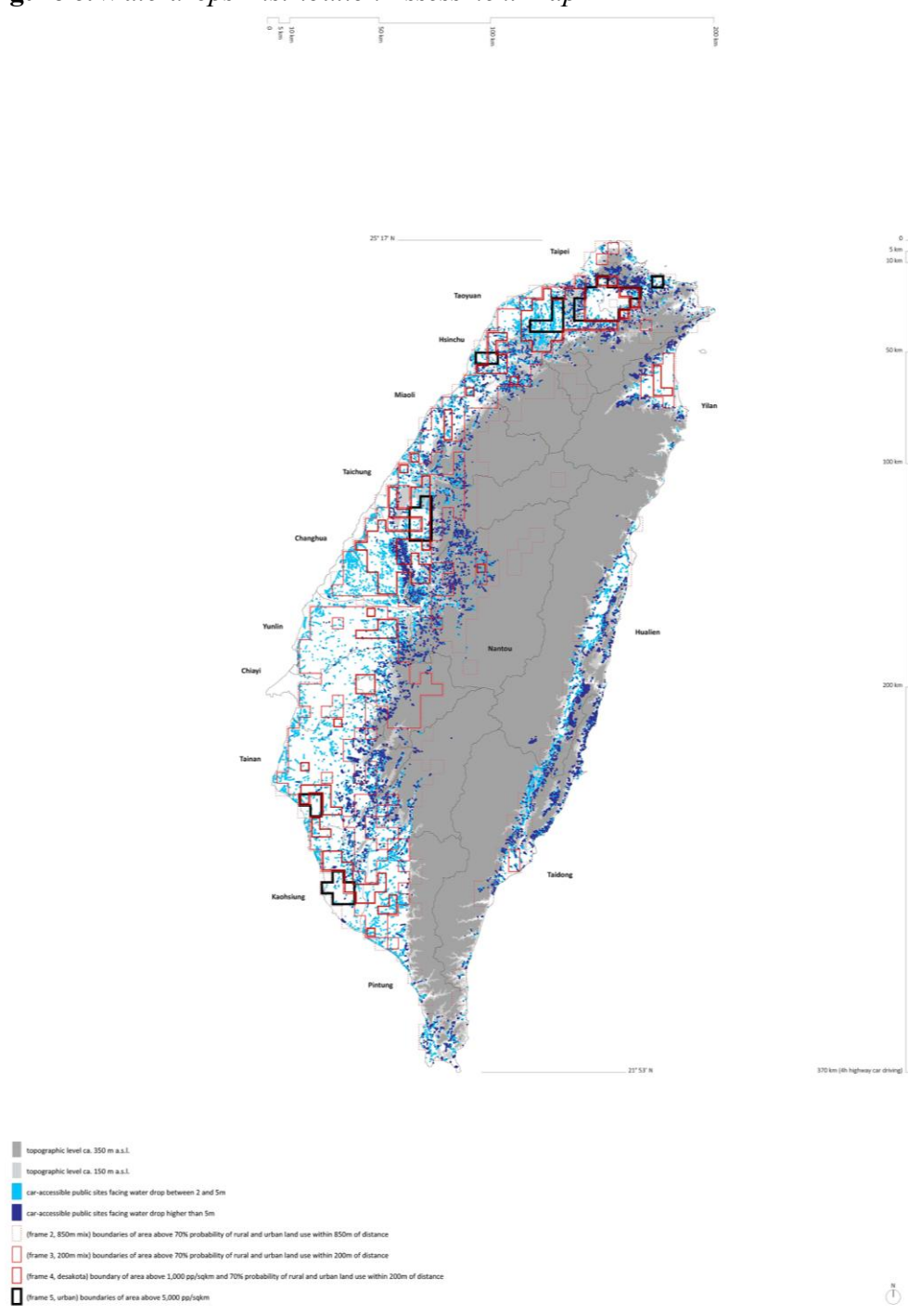
Figure 6. *Waterdrops Distribution Assessment Map*

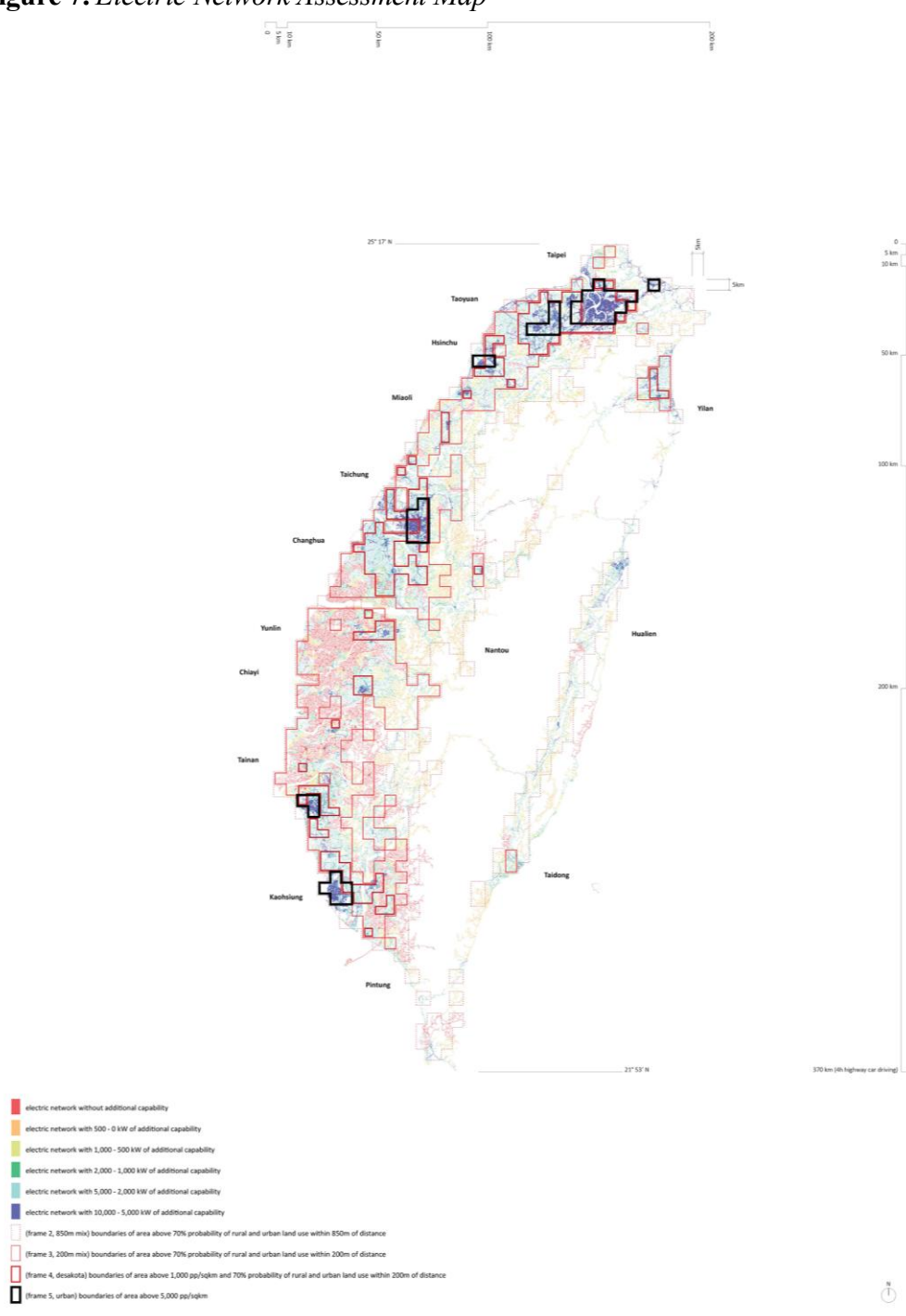
Figure 7. *Electric Network Assessment Map*

Table 1. Comparative Assessment across the Frames of Analysis

(With darker grey background hatch the highest values; with lighter grey, the second highest values.)

Frames of analysis	The data refers to the avg. value in related cells.		Car accessible water drops on public land (occurrences where the road is within 5m from the drop)			Water-courses (length of stream axis)	Grid coverage (area 50m within grid)	Grid capacities (avg. % of grid)		
	pop. (M)	grid-cells footprint (sqkm)	avg. drop x sqkm	2-5m drops	>5m drops	avg. km x sqkm	avg. % cov. x sqkm	0-2 MW	2-5 MW	5-10 MW
1. Whole island territory	23.31	39,850	1.2	0.4	0.9	0.96	20.6	54.7	31.1	14.2
2. 850 m buffer urban-rural copresence	21.42	18,050	2.3	0.7	1.7	1.57	39.4	52.5	32.6	14.9
3. 200 m buffer urban-rural copresence	12.69	9,425	2.4	0.6	1.8	1.93	50.3	49.9	37.0	13.0
4. Desakota 200 m buffer + > 1000 pp/sqkm	9.84	3,125	2.8	0.6	2.2	1.93	62.0	22.2	52.4	25.4
5. Urban > 5000 pp/sqkm	4.88	975	1.8	1.2	0.6	1.13	69.0	4.3	29.3	66.4
Reference assessment carried on the areas in between the frames of analysis										
Area between frame 1 and 2	1.89	21,800	0.3	0.1	0.2	0.47	5.0	69.4	21.2	9.4
Area between frame 2 and 3	8.73	8,625	2.3	0.7	1.5	1.18	27.5	57.3	23.9	18.8
Area between frame 3 and 4	2.85	6,300	2.2	0.6	1.6	1.92	44.5	69.1	26.4	4.5

Once hydrological data were controlled against land-use data and corrected for inconsistencies, the length of watercourses and the number of waterdrops were calculated for each cell. The density of watercourses increases in the areas characterized by urban–rural co-presence. At the island scale, the average density is 0.96 km/sqkm. This value rises to 1.57 in the 850 m co-presence frame and to 1.93 in the 200 m frame. *Desakota* presents an equivalent value, whereas urban areas record a lower density, stopping at 1.13. The inter-frame assessment makes the contrast more explicit: the territory outside the 850 m co-presence frame contains only 0.47 km/km² of watercourses, the space between the 850 and 200 m frames has 1.18, and the non-*desakota* portion of the 200 m frame has about the same density as the *desakota*.

This suggests that dense watercourse networks are associated with the finer-grained urban–rural landscapes. Anyhow, the waterdrop assessment provides a differentiation between *desakota* and non-*desakota*, possibly reacting to the parcel structure, public land, and road accessibility. At island scale, the average density is 1.2 waterdrops per square kilometre. Then, the value becomes 2.3 in the 850 m, 2.4 in the 200 m frame, and reach the highest value, at 2.8, in the *desakota*, i.e., more than twice the island-wide average and approximately 56% more than in the urban areas. The composition of these occurrences is also significant. Within *desakota*, 0.6 waterdrops per square kilometre belong to the 2–5 m height class and 2.2 to the one

of 5 m or more. In the urban areas, such a relationship is reversed. Thus, the possible advantage of *desakota* is not only quantitative, but also qualitative.

The distinction becomes even more clear if *desakota* is compared with the non-*desakota* portion of the 200 m frame. Both contain approximately the same amount of watercourses, yet lower-density mixed areas contain only 2.2 waterdrops per square kilometer, compared to the 2.8 of *desakota*. The density of 2–5 m drops is identical, whereas drops exceeding 5 m increase from 1.6 to 2.2 within the *desakota*.

Once completed the hydrologic data assessment, the electricity-network data were analyzed as a raster data set in which the network is represented as a band corresponding to an approximate 50 m pertinence zone from the grid. Within each cell, the area covered by this zone was assessed alongside the associated carrying-capacity classes. The results follow a gradient. At island scale, an average of 20.6% of each cell lies within the 50 m network-proximity zone. This rises to 39.4% in the 850 m co-presence frame, 50.3% in the 200 m frame, and 62.0% in *desakota*. Urban areas then peak at 69.0%. That is, grid proximity increases with settlement density and the intensity of urban–rural integration, although *desakota* only approaches the coverage found in the urban areas.

A more substantial differentiation appears in the distribution of available carrying capacity. At island scale, 54.7% of the grid-covered area falls within the 0–2 MW class, 31.1% within the 2–5 MW class, and 14.2% within the 5–10 MW class. The 850 m frame presents a similar distribution. In the 200 m frame, the share of the intermediate class rises to 37.0%, although half remains within the 0–2 MW class. *Desakota* presents a markedly different structure. Only 22.2% of grid-covered area belongs to the 0–2 MW class, while 52.4% lies within the 2–5 MW class and 25.4% within the 5–10 MW class. The urban core is more strongly weighted toward the highest-capacity class, with 66.4% of the grid in the 5–10 MW category. The non-*desakota* portion of the 200 m frame presents the opposite configuration. Although the watercourse density is about that of *desakota* and waterdrop density remains high, 69.1% of its grid-covered area falls within the 0–2 MW class. So, fine-grained urban–rural co-presence and hydrological availability alone do not correspond to equivalent infrastructure opportunities.

Taken together, these results reveal a non-linear relationship between urbanization and spatial conditions for distributed low-head hydropower. Rural or peripheral areas have limited grid coverage and comparatively sparse water networks. Lower-density mixed areas may contain watercourses and level changes but remain constrained by low carrying capacity of the grid. Urban areas have a strong grid coverage and capacity, yet contain fewer watercourses and drops. *Desakota* does not set record values for every individual indicator; however, it is the urban form where relevant conditions overlap most consistently. The analysis therefore identifies *desakota* as a distinctive opportunity field for distributed low-head hydropower. Although these findings are not engineering-specific and thus give strong limitations to the study, nevertheless, it remains that the combination of conditions provide an evidence basis for suggesting that the *desakota* warrants more detailed technical assessment.

Discussion

Desakota as a Conjunction of Hydrological and Electricity Infrastructure

The extent of the classified *desakota*—29% of Taiwan’s island inhabited land and 42% of its population—is consistent with earlier accounts of Taiwan as a densely populated and interwoven urban–rural territory (Liu and Tsai 1991, McGee 1991, Wu and Sui 2016). That said, the findings reveal two partly opposing territorial gradients within. Hydrological opportunity increases markedly from peripheral areas toward finer-grained urban–rural formations but declines within the urban areas. Electricity-grid coverage and carrying capacity, by contrast, increase with settlement density and infrastructural integration. *Desakota* occupies the area in which these two gradients most strongly overlap.

This finding also validates the combined use of land-use co-presence and population density in the analytic model. Co-presence identifies the morphological continuity of the mixed landscape and the density criterion distinguishes the portion of that landscape in which hydraulic structures, grid infrastructure, settlement, and economic activity have become more intensively articulated. Although the adopted density thresholds clearly remain analytical constructs, the infrastructural differences between the frames of analysis suggest that the adopted classification identifies much more than a mere demographic distinction, that is an interpretation consistent with Qadeer’s (2000) emphasis on high-density rural regions and earlier land-cover and landscape-dynamics approaches to identifying *desakota* (Sui and Zeng 2001, Xie et al. 2006, 2007), while extending those approaches to hydrological and electrical infrastructure.

Desakota as an Infrastructural Formation

The findings extend the interpretation of *desakota* beyond its conventional treatment as a pattern of mixed land use, economic transition, or metropolitan expansion. *Desakota* may also be understood as an infrastructural formation produced through the historical superimposition of irrigation systems, settlements, industrial activities, roads, and electricity networks. In this sense, it could be depicted as a “palimpsest” where a number of infrastructure have independently developed but they have finally become spatially interdependent.

This interpretation contributes to the debate between different readings of *desakota*. The analysis cannot determine whether *desakota* will remain stable over time. However, it shows that this cannot be fully described as an incomplete urban condition. Read against Moench and Gyawali (2008), the infrastructural overlap shown by the research provides spatial evidence for their account of *desakota* as a territory in which agricultural, industrial, residential, and infrastructural demands are materially interlinked. It also supports scholarship that treats hybrid urban–rural territories as context-specific formations rather than residual metropolitan fringes (McGee 2005, Ortega 2020, Gillen et al. 2022, Rajendran et al. 2024); that is, it supports approaches that treat *desakota* as a distinct formation requiring *ad-hoc* planning and, thus, possibly, implying planned developmental stabilization. However, the cross-sectional analysis

provides only a snapshot of current conditions and therefore cannot determine how the temporal restructuring of *desakota*, as identified by Hong and Kim (2023), unfolds.

The idea of an “energy potential landscape” can be here used to further articulate the point. The findings do not imply that *desakota* already functions as a coherent renewable-energy system. Rather, they refer to the spatial co-presence of potential generation conditions, electricity infrastructure, and users. Here, energy potential is not a property of a watercourse or turbine site, but a characteristic of the territorial configuration within which generation, connection, operation, and consumption would occur. This perspective complements the mostly technical and techno-economic orientation of small-hydropower research. If studies of irrigation canals, water-distribution systems, or existing hydraulic structures have demonstrated that water infrastructure may contain latent opportunities (Carravetta et al. 2012, Williamson et al. 2014, Butera and Balestra 2015, Quaranta and Revelli 2018), and later reviews principally compare technologies, performance, and cost (Klein and Fox 2022, Duah et al. 2026, Chernobrova et al. 2026), the present study adds that, when it comes to distributed generation, this depends on the form of urbanization surrounding them, too.

Desakota as a Planning and Governance Challenge

The findings therefore suggest that regional planning should incorporate territorial morphology as intermediate planning focus in between the scope of renewable-energy policies and site-specific engineering. The large number of possible distributed energy generation occurrences however raises a question of development scale, as the significance of *desakota* cannot lie in a small number of large plants but a large portfolios of small installations. This allows standardized technical assessment, coordinated procurement, shared maintenance, and aggregation of electricity production. Conversely, it can also generate high transaction costs, fragmented responsibilities, cumulative ecological effects, and so on. Thus, the territorial advantage identified cannot be separated from a study of the institutional model capable of coordinating a very large number of distributed development sites.

The findings finally reinforce the need to treat infrastructure governance as a central dimension of *desakota* planning. However, the integration of several administrative and operational domains may contrast with the institutional flexibility usually associated with the *desakota*. For example, the presence of candidate waterdrop on public land and near a road may help, but does not establish any development right. These, together with the likes of irrigation schedules, public-works regulations, environmental permits, grid-connection procedures, ownership of hydraulic structures, and long-term maintenance duties would still need to be resolved. That is, institutional and contractual dimensions of development may finally prove more restrictive than the hydraulic or electrical conditions, an interpretation that echoes Moench and Gyawali’s (2008) account of *desakota*, and hints at an action-led, ultra-context-sensitive planning, as previously suggested by Chen et al. (2017).

Limitations

The research presented in this paper is subject to several limitations. First, data sets are relatively old and produced in different years between 2016 and 2020. Although they represent a concentrated period, changes in land use, population, water infrastructure, and grid have obviously occurred since their production.

Second, the use of a 5×5 km grid allows multiple data sets to be compared at the regional scale but generalizes local conditions. Results are thus affected by the areal unit problem, especially where watercourses or settlement patterns cross cell boundaries. The 70% co-presence threshold and the population-density thresholds of 1,000 and 5,000 inhabitants/km² are analytical choices, although they are informed by existing scholarship.

Third, the waterdrop model does not calculate discharge, flow duration, seasonal variability, net hydraulic head, conveyance losses, sediment load, flood conditions, or actual energy yield. Nor does it determine whether a mapped occurrence corresponds to a natural feature, an existing hydraulic structure, or an artefact of the underlying spatial data.

Fourth, public ownership and road proximity are only preliminary indicators of accessibility to the waterdrops. They do not resolve issues concerning water rights, operational control, ecological restrictions, construction access, land-use compatibility, and so on. Similarly, watercourse density does not distinguish between channels that could potentially accommodate energy recovery and those whose ecological, flood-control, or irrigation functions would preclude intervention.

Fifth, the electricity-network assessment measures proximity to mapped infrastructure and the carrying-capacity categories available in the public utility data. It does not represent a formal grid-connection study. Actual feasibility would depend on voltage level, feeder configuration, substation conditions, protection requirements, reverse-power constraints, connection queues, planned network upgrades, and the location and cost of the required point of connection.

Sixth, population is used as a proxy for the presence of potential end users, but the study does not measure electricity consumption or demand profiles. Industrial, residential, agricultural, and public-service loads may differ substantially across the *desakota*.

Finally, the analysis identifies spatial association rather than any causation and is limited to the Taipei–Kaohsiung Mega Urban Region. Comparative studies of other Asian Mega Urban Regions are required to determine whether the observed conjunction of hydraulic infrastructure, grid capacity, and dispersed settlement is a wider characteristic of *desakota* or specific to Taiwan and the localized development pathway.

Conclusions

Regardless of their extent, the study's limitations do not undermine the validity of the findings or their implications. The study behind this paper asked whether *desakota* provides more favourable spatial preconditions for distributed low-head hydropower than urban cores and lower-density mixed territories within the Taipei–Kaohsiung Mega Urban Region. The results support this proposition in a comparative-territorial sense. The principal contribution is not the identification of *desakota* as the territory

with the maximum value for any single variable. It is the demonstration that hydrological opportunity and electricity-network capacity follow different spatial gradients and intersect most strongly within dense urban–rural formation. This non-linear relationship distinguishes *desakota* from both the urban areas and the agricultural or low-density mixed landscape.

Conceptually, the findings suggest extending *desakota* research from questions of classification, transition, and land-use mixture toward the analysis of infrastructural capacity. *Desakota* emerges as an “energy potential landscape” in the specific sense of a territory where inherited hydraulic systems, electricity infrastructure, settlement, and potential users are interwoven. This does not establish that *desakota* is inherently sustainable or that micro-hydropower development would be environmentally or economically appropriate. It indicates that the morphology of *desakota* creates a distinctive “field” within which distributed-energy opportunities warrant systematic investigation.

At least in the case study, *desakota* should therefore not be regarded solely as a transitional formation awaiting consolidation into urban space. Nor should its infrastructural density be treated uncritically as an energy resource. The study suggests that it may be better understood as a distinctive socio-ecological and infrastructural assemblage whose inherited systems may support selective forms of energy transition under appropriate technical, environmental, and institutional conditions.

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The source of all Figures and Tables is the author’s GIS elaboration, based on the data set presented in the paper.

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