Proc. of the European Safety and Reliability Conference (ESREL 2026)
Edited by José C. Matos, Paulo B. Lourenço, Michael Beer, Daniel Oliveira,
Edoardo Patelli, Hélder S. Sousa, Rui A. Silva and Monica Santamaria
© 2026 ESREL 2026 Organizers. *Published by* Research Publishing, Singapore.
doi: 10.3850/ESREL2026061419_esrel26-p26207-cd

General morphological analysis for long-term critical infrastructure resilience: a scenario-based framework

Alejandra Cue Gonzalez

Mines Paris, PSL University, Centre for Observation, Impacts, Energy (O.I.E.), 06904 Sophia Antipolis, France
E-mail: alejandra.cue_gonzalez @minesparis.psl.eu

Eric Rigaud

Mines Paris, PSL University, Centre for research on risks and crises (CRC), 06904 Sophia Antipolis, France.
E-mail: eric.rigaud @minesparis.psl.eu

The DRUID (Disaster Risk-gUided scenarIo Definition) method is a prospective approach to study the resilience of critical infrastructure against evolving threats such as natural and climate risks. It is structured around four phases. The Problem Definition phase formalizes the research question and collects data across four dimensions - hazards and exposure, absorptive capacity, infrastructure characteristics, and territorial context. The Scenario Building phase uses General Morphological Analysis to develop representative scenarios integrating general context, territorial aspects, disaster risks, and infrastructure considerations. The Resilience Study phase evaluates how risks affect infrastructure throughout its lifespan based on the DROP (Disaster Resilience of Place) and the resilience triangle models. It analyzes interactions between hazards, absorptive capacity, and the performance thresholds. The Problem Resolution phase translates scenarios into practical recommendations for infrastructure planning and management. The method is illustrated through a case study about the evolution of the risk of energy blackout in an insular context. The study models different coupling relationships and their impact on the resilience of essential infrastructures. A specific focus on the second phase is proposed, incorporating the General Morphological Analysis approach to produce prospective scenarios while considering both immediate changes and transitions as well as long-term potential evolution. Through this comprehensive approach, DRUID helps infrastructure managers better understand vulnerability patterns and develop more effective resilience strategies.

Keywords: Prospective Resilience, GMA, Power blackout, island

1. Introduction

Resilience for critical infrastructure has become a focus point for both public and private actors. Infrastructures are more vulnerable than even to severe disruptions due to extreme changes introduced by intense natural hazards, geopolitical instability, social unrest, and the consequences that stem from all these trends. However, because of the complex interactions between different infrastructures and various elements in a territory, anticipating such disruptions has become a difficult task. Data science, digital twins and prevision models are key tools that help develop resilience strategies, but they tend to focus on the short and medium term. Prospective approaches to study resilience of critical infrastructure against evolving threats are needed for the long-term vision and thus is the contribution of this proposal. Using the General Morphological Analysis to develop scenarios that represent the key aspect of interacting trends, territorial aspects, disasters risks, and infrastructure, this method proposes a transparent framework to guide resilience studies and provide practical recommendations for infrastructure planning and management. The method is illustrated through a case study about the evolution of the risk of energy blackout in an insular context. The study models different coupling relationships and their impact on the resilience of essential infrastructures. The goal is to produce prospective scenarios while considering both immediate changes and transitions as well as long-term potential evolution. Through this comprehensive approach, the method aims to help infrastructure managers better understand vulnerability patterns and develop more effective resilience strategies.

2. The DRUID method

Critical infrastructure systems face mounting challenges from climate-driven natural hazards, requiring innovative approaches to assess and enhance their resilience across their lifecycle (IPCC, 2022; Chester and Allenby, 2019). The DRUID method enriches infrastructure planning by providing an integrated three-step framework that combines climate change projections, infrastructure behavior modeling, and post-disaster decision-making analysis to support robust adaptation strategies (Hallegatte et al., 2019).

The DRUID method addresses infrastructure resilience questions through a standardized problem formulation that integrates key analysis dimensions.

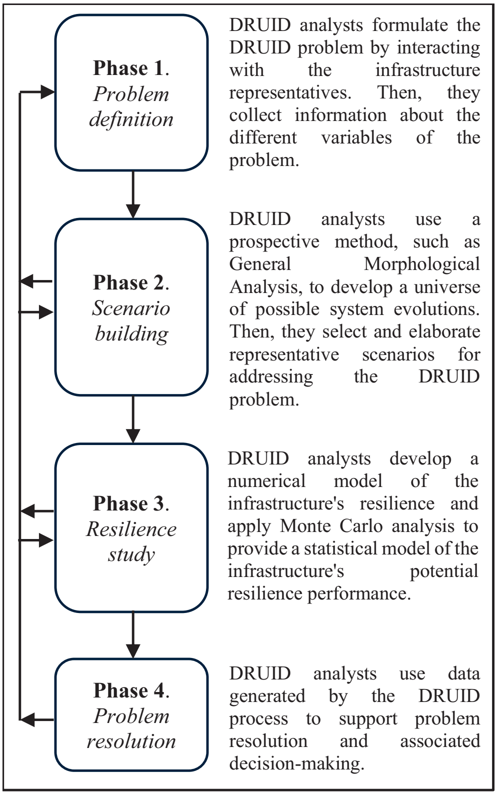
Will <trends> - driven evolution of the
<type> risks significantly affect the
<performance type> performance of <critical
infrastructure> located in <location> within
<time horizon>?

This formulation considers six essential components: the driving trends (such as climate change or urbanization), the type of risks being analyzed (natural, technological, or hybrid), the specific performance metric under study (technical, economic, environmental, or social), the critical infrastructure system of interest, its geographical location, and the temporal horizon of the analysis. This structured approach enables decision-makers to clearly articulate complex infrastructure resilience challenges while ensuring all relevant factors are considered.

For example, the DRUID formulation of a problem concerning the risk of energy blackout on a small island territory can be expressed as follows:

Will **climate change and demographic growth** - driven evolution of **cyclone and coastal flooding** risks significantly affect the **continuity of electricity supply** performance of the **electrical grid** located in a **small tropical island territory** within **the next 30 years**?

The DRUID method addresses problems through four iterative phases (cf. Fig. 1.).



DRUID analysts formulate the DRUID problem by interacting with the infrastructure representatives. Then, they collect information about the different variables of the problem.

DRUID analysts use a prospective method, such as General Morphological Analysis, to develop a universe of possible system evolutions. Then, they select and elaborate representative scenarios for addressing the DRUID problem.

DRUID analysts develop a numerical model of the infrastructure's resilience and apply Monte Carlo analysis to provide a statistical model of the infrastructure's potential resilience performance.

DRUID analysts use data generated by the DRUID process to support problem resolution and associated decision-making.

Fig. 1. The Disaster Risk-gUided scenarIo Definition (DRUID) method.

2.1. *Defining the problem*

The first phase of the DRUID method involves problem definition through two complementary activities. First, the problem is formalized using the canonical formulation to identify essential elements. Second, structured data collection is conducted across four key dimensions: hazards and exposure, absorptive capacity, infrastructure characteristics, and territorial context. This process enables identifying and characterizing key parameter classes with their associated conditions.

In the insular electrical grid case, the analysis considers cyclone intensity categories and coastal flooding return periods as the hazard class while incorporating the island's topographical constraints, coastal exposure, and tropical climate characteristics within the territory class. The infrastructure's absorptive capacity is characterized by the grid's resistance thresholds to high winds and flooding, including transmission line resilience and power plant protection levels. The infrastructure technology class encompasses the energy generation mix (thermal, photovoltaic, wind turbines), grid architecture, and energy storage systems. Each parameter class is then defined with specific conditions that can evolve based on identified driving trends, such as increasing cyclone intensity and rising sea levels, over the 30-year study period.

2.2. *Building scenarios*

The second step of the DRUID method focuses on scenario building using the General Morphological Analysis approach (Ritchey, 2011). Based on data collected in step one, a morphological box represents the universe of possible scenarios. Through Cross-Consistency Assessment, this universe is refined to identify a solution space of feasible context scenarios, from which representative scenarios are selected for detailed analysis.

Each selected scenario is then structured through four interrelated contextual dimensions. First, the general context describes global trends affecting the territory and infrastructure sectors. Second, the territorial context details specific geographical, political, and demographic evolution. Third, the disaster risk context outlines changes in hazard characteristics and infrastructure absorptive capacity. Fourth, the infrastructure context describes sectoral developments, including technological advances and policy changes.

For the insular electrical grid case, this might explore how climate change affects cyclone frequency and intensity in the tropical region, how sea-level rise increases the island's exposure to storm surge and coastal flooding, how population growth and urban development impact energy demand and grid vulnerability, how energy generation technologies evolve to enhance grid robustness and integrate renewable sources, and how energy transition and territorial planning policies adapt to climate challenges over the 30-year timeframe.

2.3. *Studying infrastructure resilience*

The third step of the DRUID method leverages the context scenarios to assess critical infrastructure resilience through an iterative modeling approach. This assessment examines how disaster risks affect infrastructure resilience throughout its lifespan while considering various maintenance decision alternatives. The analysis produces decision scenarios that reflect different adaptation strategies.

In the case of the insular electrical grid, the resilience assessment considers several types of post-disaster decisions: emergency repair of damaged transmission lines and distribution networks, replacement of vulnerable grid components with more resilient alternatives such as underground cabling, and comprehensive grid modernization through microgrid deployment or decentralized renewable energy systems. This modeling approach evaluates how different cyclone and flooding scenarios might affect the continuity of electricity supply and how various adaptation strategies could reduce blackout duration and frequency over 30 years. The resulting decision scenarios provide insights into optimal investment strategies that balance service continuity, economic cost, and energy transition objectives under evolving climate risk conditions

2.4. *Solving the DRUID problem*

The final step of the DRUID method focuses on translating decision scenarios into actionable insights for infrastructure planning and management. This step integrates the resilience analysis results with performance assessment frameworks to evaluate the implications of different adaptation strategies. For each decision scenario, key performance indicators are calculated to assess their effectiveness, feasibility, and long-term impacts. This comprehensive evaluation supports evidence-based decision-making by providing quantitative and qualitative data on the trade-offs between different adaptation options.

In the insular electrical grid case, this analysis might compare the long-term implications of different adaptation strategies under evolving cyclone and flooding risk scenarios, considering factors such as blackout frequency and duration, grid reliability indices, cost of damages and repairs, and progress toward energy autonomy. This integrated assessment helps decision-makers select optimal adaptation strategies that enhance grid resilience while advancing the island's energy transition and self-sufficiency objectives over the 30-year timeframe.

The next section focuses on the second phase of the DRUID method.

3. *Building prospective scenarios*

The second phase of the DRUID method aims at constructing prospective scenarios that capture the full range of plausible futures for the critical infrastructure under study. Rather than relying on trend extrapolation or expert intuition alone, this phase employs a structured combinatorial approach to ensure that the scenario set is both exhaustive and internally consistent. In the context of infrastructure resilience, this is essential because the interactions between climate evolution, territorial development, hazard dynamics, and infrastructure states produce a complex problem space that cannot be adequately covered by a limited number of intuitively derived scenarios.

In the insular energy blackout case, the objective is to characterize all relevant combinations of conditions that may affect the electrical grid's resilience over the 30-year horizon. The island's energy system presents specific vulnerabilities: geographic isolation limits interconnection possibilities with continental grids, the small scale of the network amplifies the impact of localized disruptions, and tropical climate exposure introduces severe hazard conditions including cyclones and coastal flooding. These characteristics make conventional scenario approaches particularly inadequate, as they tend to focus on most likely developments while underrepresenting the extreme but plausible combinations that are most critical for resilience planning (Johansen, 2018).

To address these challenges, the method relies on General Morphological Analysis (GMA) as a structured approach to explore the entire solution space of possible scenarios while ensuring internal consistency and completeness (Ritchey, 2011). The following subsections present the GMA method and its application to the insular energy blackout problem.

3.1. *The General Morphological Analysis method*

General Morphological Analysis (GMA) is a method for non-quantified modelling originally developed by Swiss-American physicist Fritz Zwicky (1969), who applied it to fields ranging from astronomy to technological forecasting and social problem solving. In its generalized formulation, GMA aims at identifying and structuring all possible aspects and solutions for non-reducible, complex problem spaces (Álvarez and Ritchey, 2015). These problems typically involve human behavior, political choice, and normative processes, making them inaccessible to purely quantitative or causal modelling approaches. Finding solutions to such problems therefore requires what Zwicky himself characterized as "totality research" – an uncompromising openness to the full range of possibilities (Zwicky, 1969).

As Johansen (2018) describes, the GMA process using the method of the Morphological Box proceeds through five distinct steps. The first step requires a formulation of the problem that is as precise as possible, while acknowledging that a complete delineation may be unlikely. In the second step, the problem is decomposed into a set of parameters that frame the problem space. Each parameter must be precisely defined, and an exhaustive and mutually exclusive set of possible states – or values – pertaining to each parameter has to be established. Good parameters should be meaningful, equally important, abstract, straightforward, and independent of each other (Stenström, 2013). For defining value ranges, a useful approach is to begin by identifying the end points – the most comprehensive and the most constricted values – before determining intermediate values.

The third step involves the construction of the morphological box – a multidimensional matrix where parameters appear in the top row and their values are listed in columns. Each cell combination across all parameters constitutes one "configuration" or potential solution. The morphological box thus contains within itself the entire morphological field, i.e. all configurations that can be constructed from the parameter set. However, the morphological field usually contains a large proportion of inconsistent or impossible configurations. Even a relatively small matrix can produce a prohibitively large number of theoretical solutions: a matrix with four parameters each having three values already generates 81 configurations, while six parameters with four values each would produce 4,096.

The fourth step therefore entails a thorough analysis of the morphological field through a Cross-Consistency Assessment (CCA) to reduce noise and delineate a refined solution space. The CCA works by systematically examining each pair of values across parameters. Consistency is assessed on two criteria: logical consistency, meaning the internal relationships of the concepts cannot be mutually contradictory; and empirical consistency, meaning a solution cannot rest on empirically impossible or highly improbable assumptions (Johansen, 2018). Since the number of value pairs increases at a much lower rate than the number of configurations, a relatively small number of pairwise assessments suffices to analyze even a large morphological field. It is not unusual for this process to reduce the morphological field by more than 90%. In the fifth and final step, the remaining solution space is surveyed and the most representative solutions are selected for practical application.

A key advantage of GMA for infrastructure resilience studies is its capacity to systematically explore all possibilities within a problem space, including outlying and discontinuous configurations that forward-looking causal reasoning might overlook (Johansen, 2018). Conventional scenario approaches, such as the Intuitive Logics method, tend to focus on driving forces and trend-based developments, which may underrepresent rare but high-impact events (Wright and Goodwin, 2009). In the context of insular energy systems, this limitation is particularly problematic because the most critical threats, major cyclones, compound flooding events, or cascading infrastructure failures – are precisely those that lie beyond normal trend trajectories. Furthermore, the CCA process provides a transparent audit trail from problem formulation to scenario selection, allowing external review and ensuring that every elimination of a configuration is documented and justified (Ritchey, 2011; Álvarez and Ritchey, 2015). This methodological transparency is valuable for infrastructure planning contexts where decisions must be communicated to diverse stakeholders.

3.2. *Methodology*

Following the GMA process described above, the scenario building for the insular energy blackout case proceeds through the systematic construction and analysis of a morphological box. Based on the data collected during the problem definition phase (cf. Section 2.1), we identify four contextual dimensions that frame the universe of possible scenarios: general context, territorial context, disaster risk context, and infrastructure context. Each dimension constitutes a parameter in the morphological matrix, and each is defined with a set of exhaustive and mutually exclusive values that capture the range of plausible evolutions over the 30-year study period.

The general context parameter captures macroscopic trends that influence the territory and its energy sector at a global or regional scale. Three values are defined for this parameter: (i) accelerated climate change, characterized by rapid temperature increase, intensified natural hazards, and heightened geopolitical tensions around energy resources; (ii) moderate climate evolution, with gradual warming and progressive international adaptation efforts; and (iii) stable conditions, with no significant departure from current climate and geopolitical trends. These values are informed by IPCC climate projections and regional climate models applicable to the tropical zone under consideration (IPCC, 2022).

The territorial context parameter describes the local evolution of the island territory across demographic, economic, and urban dimensions. Its values include: (i) strong demographic and urban growth, leading to significant increases in energy demand, expansion of coastal settlements into hazard-prone areas, and higher pressure on existing infrastructure; (ii) moderate development, with controlled urbanization, diversified economy, and managed coastal zones; and (iii) demographic decline, potentially driven by economic migration, resulting in reduced energy demand but also diminished investment capacity for infrastructure maintenance and modernization.

The disaster risk context parameter characterizes the evolution of the hazard landscape and the territory's vulnerability to natural disasters. Three values are defined: (i) significant intensification of cyclone frequency and severity combined with accelerated sea-level rise, increasing both direct damage to energy infrastructure and indirect disruptions through flooding of access routes and supply chains; (ii) moderate increase in hazard severity, with occasional intense events but overall manageable risk levels; and (iii) stable hazard patterns with improvements in early warning systems, forecasting capabilities, and emergency preparedness that partially offset any underlying climate trends.

The infrastructure context parameter describes the state and technological evolution of the insular energy system. Its values include: (i) aging grid, characterized by limited renewable energy integration, high dependency on imported fossil fuels, overhead transmission lines vulnerable to high winds, and centralized generation with single points of failure; (ii) progressive energy transition, with hybrid generation combining thermal, photovoltaic, and wind sources, partial grid undergrounding, introduction of battery storage systems, and reinforcement of critical network nodes; and (iii) advanced decentralized energy system, featuring widespread microgrid deployment, significant distributed storage capacity, high renewable penetration reducing fossil fuel dependency, and smart grid technologies enabling rapid islanding and load management during disruptions.

The resulting morphological box with four parameters and three values each generates 3 × 3 × 3 × 3 = 81 possible configurations. The number of value pairs to be assessed in the CCA is 4 × C(3,1) × C(3,1) × C(4,2)/(pairs across parameters) = 54 pairs, which is a manageable number for systematic expert evaluation. Each pair is assessed for both logical consistency and empirical plausibility.

Several types of inconsistencies can be identified. Logical inconsistencies include combinations where demographic decline is paired with strong increase in energy demand, or where stable hazard conditions are combined with accelerated climate change. Empirical inconsistencies involve configurations that, while not logically impossible, are assessed as highly improbable given real-world constraints: for instance, the deployment of an advanced decentralized energy system under conditions of accelerated climate change and strong demographic growth would require investment levels that are empirically unlikely without massive external support; similarly, an aging grid maintaining adequate service under intensified cyclone conditions is implausible over a 30-year horizon. This assessment process is conducted collaboratively with domain experts in energy systems engineering, tropical climatology, and territorial planning, ensuring that the judgments reflect current scientific knowledge and operational experience.

The CCA substantially reduces the 81 theoretical configurations to a solution space containing only feasible context scenarios. From this solution space, representative scenarios are selected to cover the full range of plausible futures while minimizing redundancy. The selection follows Johansen's (2018) approach of grouping similar configurations into scenario classes – qualitatively distinct categories that together span the entire solution space. Each representative scenario is then elaborated as a structured narrative describing the coupled evolution of climate, territory, hazards, and infrastructure across the three decades of the study period.

These narratives serve as the direct input for the resilience study conducted in the third phase of the DRUID method (cf. Section 2.3). By providing a comprehensive and consistent set of context scenarios, the GMA-based approach ensures that the subsequent resilience assessment covers the full spectrum of conditions the insular electrical grid may face, from gradual degradation under moderate stress to catastrophic disruption under compound extreme events. This structured approach guarantees that no significant combination of conditions is overlooked and that no scenario rests on contradictory assumptions, thereby providing infrastructure managers and territorial planners with a robust basis for strategic decision-making.

3.3. *Representative scenario narratives*

Following the Cross-Consistency Assessment, four representative context scenarios are retained from the solution space. Each scenario describes a coherent 30-year trajectory combining general, territorial, hazard, and infrastructure evolutions. These scenarios are not predictions but structured representations of plausible futures against which resilience strategies can be evaluated.

Scenario A *Climate rupture and infrastructure stress*

This scenario combines accelerated climate change with strong demographic and urban growth on the island. Cyclone frequency and intensity increase significantly over the three decades, with category 4 and 5 events becoming more frequent in the second and third decades. Sea-level rise exacerbates coastal flooding, particularly in low-lying areas where new settlements and industrial zones have expanded. The electrical grid, however, remains largely in its current state: centralized thermal generation dominates, transmission lines are predominantly overhead, and renewable integration remains marginal due to competing investment priorities driven by rapid urbanization. Energy demand grows steadily, outpacing generation capacity and creating chronic supply tension even in the absence of extreme events. When major cyclones strike, the combination of an aging, overstretched grid and increased exposure leads to prolonged blackouts lasting several weeks, with cascading effects on water supply, telecommunications, and health services. Recovery is slow due to supply chain disruptions caused by port and road flooding. This scenario represents the most severe resilience challenge and serves as a stress test for adaptation strategies.

Scenario B ***Progressive transition under moderate stress***

In this scenario, climate change follows a moderate trajectory with gradual warming and a slight increase in cyclone intensity. The island experiences moderate demographic growth with controlled urbanization guided by territorial planning policies that limit coastal exposure. The energy system undergoes a progressive transition: hybrid generation combining thermal, photovoltaic, and wind sources is deployed, critical transmission segments are undergrounded, battery storage systems are introduced at key network nodes, and grid reinforcement programs are implemented in the most vulnerable areas. Energy demand grows but is partially offset by efficiency measures. When cyclone events occur, the reinforced grid sustains less damage and recovers more rapidly than in Scenario A. Blackouts are shorter in duration and more localized. However, the transition remains incomplete by the end of the 30-year period, leaving residual vulnerabilities particularly in peripheral areas of the island where grid modernization has not yet reached. This scenario represents a realistic middle path where adaptation efforts are underway but face resource and time constraints.

Scenario C ***Advanced resilience through decentralization***

This scenario assumes moderate climate evolution combined with moderate territorial development and a proactive energy transition strategy. The island's energy system is transformed through widespread deployment of microgrids, significant distributed storage capacity, high renewable penetration (photovoltaic and wind), and smart grid technologies that enable rapid islanding and automated load management. Fossil fuel dependency is substantially reduced, improving both energy autonomy and supply chain resilience. The decentralized architecture means that when a cyclone damages part of the network, unaffected microgrids continue to operate independently, maintaining electricity supply to critical facilities (hospitals, water treatment, emergency services) and residential areas. Recovery times are significantly shortened because repairs can be prioritized on interconnection segments rather than requiring restoration of the entire centralized network. Even under occasional intense cyclone events, blackout duration and extent are limited. This scenario illustrates the potential benefits of a fully committed decentralization and energy transition strategy, though it requires sustained investment and institutional coordination over the entire 30-year period.

Scenario D ***Demographic decline and slow degradation***

In this scenario, the island experiences demographic decline driven by economic migration, resulting in a shrinking population and reduced energy demand. Climate conditions remain relatively stable with no major intensification of natural hazards. However, the declining population also means reduced tax revenue and diminished investment capacity for infrastructure maintenance. The electrical grid ages progressively without significant modernization. While the reduced demand alleviates supply tension, the deteriorating condition of transmission lines, transformers, and generation equipment increases the frequency of technical failures unrelated to natural hazards. When occasional cyclone events do occur, the weakened infrastructure sustains disproportionate damage relative to the event's intensity. Blackouts become more frequent but are generally shorter than in Scenario A because demand is lower and the territory is less densely populated. This scenario highlights the paradox of declining territories where reduced exposure is offset by reduced adaptive capacity, and raises questions about the long-term viability of maintaining centralized infrastructure for a shrinking population.

These four context scenarios span the solution space from worst-case compound stress (Scenario A) to best-case advanced adaptation (Scenario C), with intermediate trajectories reflecting either progressive efforts under constraint (Scenario B) or structural decline with residual vulnerability (Scenario D). Together, they provide a comprehensive basis for the resilience study phase, enabling the assessment of infrastructure performance and decision-making strategies across qualitatively distinct futures.

4. Conclusion

This paper has presented the application of the DRUID methodology to the assessment of insular electrical grid resilience against evolving climate and natural hazard risks. The problem definition phase formalized the research question around the risk of energy blackout on a small tropical island territory, while the scenario building phase, the core focus of this paper, demonstrated how General Morphological Analysis can construct a comprehensive and internally consistent set of prospective scenarios. By decomposing the problem into four contextual parameters and systematically evaluating all configurations through a Cross-Consistency Assessment, the method identifies representative scenario classes spanning the entire solution space of plausible futures.

The GMA-based approach offers key advantages for insular infrastructure resilience studies: exhaustiveness through systematic exploration of all parameter combinations, internal consistency guaranteed by pairwise assessment, and methodological transparency supporting communication with diverse stakeholders. This structured exploration reveals not only the most visible threats, such as cascading grid failures under severe cyclone events, but also less obvious vulnerability pathways driven by demographic decline and underinvestment.

Future research will focus on completing the DRUID application to a specific island territory, including the resilience study phase with Monte Carlo simulations to quantify blackout frequency and recovery dynamics under the identified scenarios. Further developments will explore interdependencies between the electrical grid and other critical networks (water, telecommunications, transportation), and the integration of energy transition trajectories to support decision-making that simultaneously enhances resilience and advances energy autonomy.

References

Álvarez, A., and T. Ritchey. “Applications of General Morphological Analysis from Engineering Design to Policy Analysis.” *Acta Morphologica Generalis* 4 (2015).

Chester, M. V., and B. Allenby. “Infrastructure as a Wicked Complex Process.” *Elementa: Science of the Anthropocene* 7, no. 1 (2019): 21. https://doi.org/10.1525/elementa.360.

Hallegatte, S., J. Rentschler, and J. Rozenberg. “Lifelines: The Resilient Infrastructure Opportunity.” Washington, DC: World Bank Publications, 2019. https://doi.org/10.1596/978-1-4648-1430-3.

IPCC. “Climate Change 2022: Impacts, Adaptation and Vulnerability.” Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2022. https://doi.org/10.1017/9781009325844.

Johansen, I. “Scenario Modelling with Morphological Analysis.” *Technological Forecasting and Social Change* 126 (2018): 116–125. https://doi.org/10.1016/j.techfore.2017.05.016.

Ritchey, T. “Modeling Alternative Futures with General Morphological Analysis.” *World Futures Review* 3, no. 1 (2011): 83–94. https://doi.org/10.1177/194675671100300105.

Stenström, M. *Morphological Analysis in Groups: A Personal Guide*. FOI-R–3678–SE. Stockholm: Swedish Defence Research Agency, 2013.

Wright, G., and P. Goodwin. “Decision Making and Planning under Low Levels of Predictability: Enhancing the Scenario Method.” *International Journal of Forecasting* 25, no. 4 (2009): 813–825. https://doi.org/10.1016/j.ijforecast.2009.05.019.

Zwicky, F. *Discovery, Invention, Research through the Morphological Approach*. Toronto: The Macmillan Company, 1969.