Transforming Spatial Data into Public Policies for Social Justice and Environmental Sustainability

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INTRODUCTION

THE QUEST FOR SUSTAINABILITY: LAW AND GIS FOR TERRITORIAL JUSTICE. (TRANSFORMING SPATIAL DATA INTO PUBLIC POLICIES FOR SOCIAL JUSTICE AND ENVIRONMENTAL SUSTAINABILITY)

ALEXANDRA ARAGÃO (COORD.)

This book develops the concept of territorial injustice and related methodologies with the aim of contributing to justice-oriented public policies. It is organized in fifteen chapters.

The first chapter, by Alexandra Aragão, from Portugal, sets the scene for disciplinary hybridization, which is crucial for sustainable territorial development: law, sociology, geography and informatics must operate together to prevent territorial injustice and produce better public policies. The concept of territorial injustice, a typology of injustice; the tools for identifying injustice; and the public policy measures that can be adopted to compensate for and offset unfair impacts are presented in this chapter.

Over the next few chapters, the book demonstrates how geographic information systems can be used to support better public policies aimed at correcting territorial injustice as a result of the inequitable overlap of environmentally harmful activities and vulnerable populations in the same country, region or place. Activities associated with economic development, such as steel mills, cement plants, pulp mills, power plants, hydropower dams, airports, railroads and mining activities, often generate strong negative environmental impacts. The impacts are felt mainly by neighboring vulnerable human communities that are more exposed than others to threats to their health and well-being and to activities that jeopardize their right of access to clean air, water, soil and healthy food, thus disrupting their individual and collective rights.

In chapter two, on environmental impact assessment, Larissa Boratti, from Brazil, elucidates the links between law and geography and how geographic information systems are used in the context of environmental policies to support informed and qualified decision-making processes. The environmental assessment of projects likely to have environmental impacts is the first step of the method developed to identify the unfair distribution of environmental burdens in a territory. Performing an accurate environmental assessment that correctly identifies mitigation and compensatory measures is critical to delivering peace and justice.

In chapter three, on the use of geoinformation systems by prosecutors' offices, Luiz Ugeda and João Santa Terra Jr address the benefits and risks of using geoinformation systems in countries facing challenges associated with personal data protection. The massive amounts of data available in an algorithmic reality can both contribute to improved public policies and be used as an instrument of power and repression, ultimately harming citizens.

In chapter four, Verónica Yáñez-Romo and Carlos Muñoz-Parra, from Chile, describe the factors and variables of the identification of social vulnerability in the administrative and political divisions of various countries. This is an important step in the method for dealing with territorial injustice and compensating for inequalities. The case study carried out in Chile provides a practical confirmation of the feasibility of using objective and measurable criteria to affirm that a local community is particularly vulnerable.

In chapter five, Alvaro Anguix, from Spain, elucidates the potential of geomatics to produce geographic information systems and spatial data infrastructures that can be used to analyze geographic information, thus contributing to the hybrid discipline of geolaw and fulfilling the goal of territorial justice.

In the next chapter, Morato Leite, Bruno Peixoto and Maria Leonor Codonho, from Brazil, set forth how the so-called geolaw, a transdisciplinary and non-fragmented approach to environmental protection, may give rise to a new generation of environmental law for the implementation of national environmental policy. Considering the increasing frequency of climate and environmental catastrophes, environmental law must be better equipped with a series of instruments that effectively contain the consequences of risks for humanity and the planet.

Virginia Fernández and Yuri Resnichenko, from Uruguay, use the example of severe water contamination in Uruguay in chapter seven to show how spatial data infrastructures can be used to support the adoption of corrective laws and regulations aimed at preventing the poor use of water

ecosystems for wastewater disposal and protecting the right to clean and safe water.

Yanelys Delgado Triana, José Luis Córdova, Jorge Milián Gómez, and Ernesto Fariñas Wong, from Cuba, explore in chapter eight the emerging use of geographic information as a tool to assist public authorities in environmental decision-making. In the case of Cuba, the use of maps has demonstrated that georeferenced information can produce better decisions in terms of both environmental effectiveness and social fairness.

Taking a more academic approach, the subsequent chapters introduce the theoretical foundations of the use of geographic information systems by public authorities.

In chapter nine, Silvia Nonna, from Argentina, explains the relevance of the 2021 Escazu International Agreement adopted in the Latin America and Caribbean region regarding access to information, public participation and access to justice in environmental matters. This fundamental legal instrument of international law sets the foundation for the duty of public authorities and the rights of citizens with regard to access to environmental information. The Escazu Agreement determines that the state parties "shall guarantee that environmental information systems are (...) made progressively available through information technology and georeferenced media" (article 6/3). The Escazu Agreement means for Latin American countries what the Aarhus Agreement meant for European countries: it is a guarantee of transparent and democratic public policies and reduced environmental impacts.

Similarly, Gustavo Hernández Arteaga, from Cuba, in chapter ten addresses the legal principles of environmental administrative management, focusing especially on subsidiarity, for the integrated local regulation of a territory. Subsidiarity is a guiding rule for the functioning of the municipal organic administration, as the use of geospatial data, public participation and governmental transparency are indicators of territorial justice at the local level.

Fernanda Paula Oliveira, from Portugal, concentrates in chapter eleven on strategies for promoting urban territorial justice, one of which is the adoption of new forms of city management that are open to negotiation, participation and the compatibility of various interests and in which geodata play a central role.

The final chapters are case studies on territorial justice in Colombia, Brazil, Mexico, Costa Rica, and Spain.

Chapter twelve, by Angarita Pinto, Martelo Jimenez, Mesa Cuadros, Parra and Rojas Bonilla, reports on three case studies of ethnic communities, peasant communities and urban recycling communities in

Colombia. The study analyzes how to establish an interethnic and intercultural dialog between academia and different communities to ensure that geographic information systems include the vision of territoriality, opening a scenario of greater equity and participation for those who do not have *a voice*.

In chapter thirteen, José Irivaldo Alves O. Silva and Ana L. Burgos, from Brazil and Mexico, compare the concept of river basins in the two countries to demonstrate that territorial injustice can be reduced with a new watershed approach. The two case studies are the contamination of the Rio Doce basin in Minas Gerais, Brazil, and the marginalization of the rural population living in the basin of Embalse Infiernillo-Bajo Balsas (Mexico).

The following chapter by Carlos Peralta and Marcela Moreno Buján, from Costa Rica, illustrates the concept of territorial injustice with a real example of vulnerable indigenous communities whose human rights are affected because they are located in areas without access to a safe water supply and means of sanitation. Although there is no water scarcity, high levels of water contamination from different sources pose a risk to human health.

In the closing chapter, David San Martín Segura and Lucía Muñoz Benito, from Spain, present the historic evolution of a well-known case of territorial injustice recognized by the European Court of Human Rights and famous as the first case in which the right to a home and to noninterference in private and family life was used to condemn a state for tolerating serious environmental disturbances. More recently, several other court cases have shown how the European Court of Human Rights treats territorial injustice, recognizing it as a violation of human rights.

CHAPTER ONE

NEW CONCEPTS AND A NEW TRANSDISCIPLINARY METHODOLOGY TO DEAL WITH TERRITORIAL INJUSTICE

ALEXANDRA ARAGÃO

Keywords: environmental justice, territorial justice; NIMBY syndrome; environmental impact assessment; public policies

1. Introduction: The JUST-SIDE Network

In 2018, an international scientific network called "Justice and Sustainability through a Spatial Data Infrastructure" (JUST-SIDE) was launched. The network is financed by the Ibero-American Programme on Science and Technology for Development (CYTED-UNESCO). It brings together twelve research institutions of Ibero-American countries, from universities and academic research centers to companies and organizations with expertise in geolaw and geomatics. The objective of the JUST-SIDE network is to develop a methodology to identify and correct unfairness stemming from the geographical coincidence of social and environmental injustice. The interdisciplinary work carried out over four years has been published in books (Aragão, 2018; Aragão and Santos, 2019), articles (Aragão, 2021) and related documents. The current book condenses the major contributions of the JUST-SIDE method.

Understanding the potential of the JUST-SIDE methodology requires making a clear distinction among three connected but different concepts: social injustice, environmental injustice, and territorial injustice.

In legal terms, social injustice is an unequal distribution pattern of wealth, access to rights, and essential public services that leaves behind disadvantaged persons, weak communities, and vulnerable social groups, such as the disabled, elderly individuals, infants, racial and ethnic

minorities, religious minorities, sexual minorities, refugees, less educated individuals, and low-income individuals (ILO, 2008).

Environmental justice involves recognizing vulnerable groups that are disproportionately exposed to negative environmental externalities originating from ongoing or proposed projects or activities. Therefore, environmental injustice is the uneven exposure to human-made environmental pollution and anthropogenic environmental hazards that adversely affects those who live or work near sources of pollution (Eurostat, 2019).

These findings are essential for realizing that environmental risks are unevenly distributed in society (EEA, 2018) and that some vulnerable groups, such as racial or ethnic minorities, migrants, elderly persons, the unemployed and simply the economically disadvantaged, are more affected by these risks than the rest of society is (Bullard, 2000).

Consequently, territorial injustice is the inequitable overlap in the same country, region or place of vulnerable populations and environmentally harmful activities (Aragão ,2021).

The JUST-SIDE conceptual framework goes beyond environmental justice by adding territory as a critical component for developing public policies to fight environmental injustice and promote territorial justice.

$$\frac{\text{Law}+(\text{Geography}+\text{Informatics})^{\text{Geomatics}}}{\text{Territorial justice}} = \begin{pmatrix}\text{Better}\\ \text{public}\\ \text{policies}\end{pmatrix}$$

Territorial justice is the result of strategies, policies and measures to prevent the geographical coincidence of social injustice and environmental injustice.

Territorial justice is an umbrella notion referring to the unfair distribution of environmental burdens in a territory and among communities. The JUST-SIDE conceptual framework assumes that for multiple reasons, underprivileged groups and communities are most exposed to pollution and other environmental nuisances and risks because they live in geographic areas surrounding the locations of certain human activities that are the sources of such nuisances and risks (Boyne, 1991;

Cutter, 2006). Therefore, this problem should be corrected at the source (Krämer, 2018).

2. From NIMBY Syndrome to GRAFITE Activities

Economic activities, which are recognized as corresponding to an overriding public interest, often generate a paradoxical feeling of rejection within neighborhoods and among environmental activists, usually based on the *not in my backyard* (NIMBY) syndrome (Hager & Haddad, 2015). The NIMBY syndrome engenders a feeling of discrimination and unfairness (Davy, 1997) that sometimes materializes in public demonstrations or in moving to another place (Banzhaf et al., 2008).

When defining the scope of territorial injustices and proposing ways to address them, an important component of the JUST-SIDE conceptual framework is the definition of what have been called "GRAFITE activities", an acronym referring to activities related to environmental risk generators and focuses of avoidable territorial injustice (**G**eradoras de **R**iscos, **A**mbientais e **F**ocos de **I**njustiça **T**erritorial **E**vitável) (Figure 1).

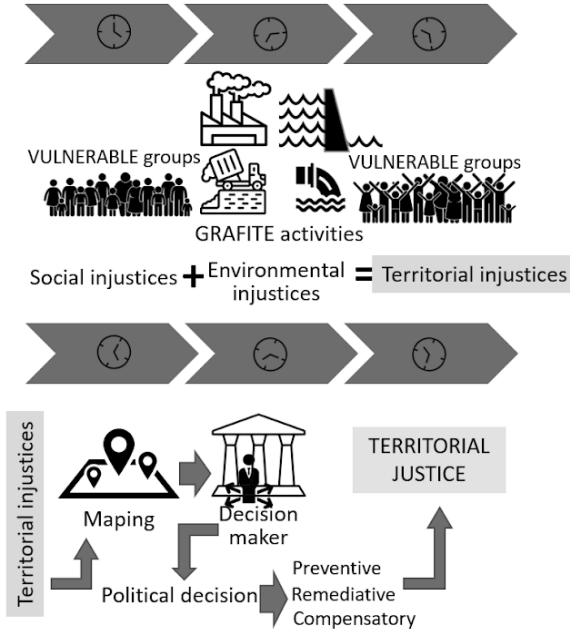

Figure 1. Conceptual framework of the JUST-SIDE network.

Some examples of GRAFITE activities and infrastructure are waste management facilities such as landfills, wastewater treatment plants, mines, oil extraction, fuel depots, large hydropower dams, large industrial combustion plants such as steel mills, cement plants, waste incinerators, thermoelectric power plants, airports and other facilities generating negative environmental impacts and jeopardizing the right of access to clean air, water, and soil and healthy ecosystems. These activities affect the individual and collective rights of vulnerable social groups.

Unfair geographic coincidence between GRAFITE activities and social vulnerability can happen in three moments:

- Moment 1: Proximity—GRAFITE activities are very often located, for economic reasons, in less privileged areas, which are sometimes sparsely populated, where land is cheaper and where there is less access to essential public services. This is where more vulnerable populations are likely to live.
- Moment 2: Withdrawal—After the commencement of a GRAFITE activity, neighbors with greater economic power, greater access to information, stronger social networks, and greater personal and professional mobility are free to move away from the site. Those who do not have such means are forced to stay and are exposed to the increased risks and negative externalities of the GRAFITE activity.
- Moment 3: Reapproximation—The devaluated vacant houses are bought by low-income families who settle near the GRAFITE activity, giving rise to a second generation of victims of territorial injustice.

Thus, through a pernicious process of "natural selection", the most vulnerable populations, who have no informational or economic means of challenging the location of a GRAFITE activity and who have no personal, family or professional means to move away from it, end up having to coexist with such activities and suffer from the negative externalities that harm their health and well-being.

3. Why Geography Matters

Living in safe environments is a condition of the utmost importance for human health and well-being (CSDH, 2008). The right to live in a healthy environment is recognized in many constitutions throughout the world (UN SRHRE, 2020). However, the prevalence of vulnerable social groups living in deteriorated environments is growing (Eurostat, 2019). The World Health

Organization has gathered evidence of frequent overlap between multiple inequalities:

- housing-related inequalities (lack of flush toilets, lack of baths or showers, overcrowding, damp housing, thermal discomfort),
- basic service inequalities (reduced access to drinking water services, no access to basic sanitation services, energy poverty),
- work-related and transport inequalities (work-related injuries and mortality, risks in the working environment, fatal road traffic/transport injuries), and
- environmental inequalities (exposure to air pollution, noise annoyance, chemicals, and contaminated sites and lack of access to recreational or green areas) (WHO, 2019).

In addition, the same populations are more vulnerable to natural risks such as earthquakes, heat waves and hurricanes (Driesen et al., 2005).

Territorial injustice (Boyne and Powel, 1991; Rauhut, 2017)—also called spatial justice (Pirie, 1983)—is a result of several of these inequities (Wilkinson and Pickett, 2009) occurring in the same country, region, or place. Furthermore, territorial injustice can occur among countries (EEA, 2018) and thus is a cross-cutting and international problem.

The overlap between social injustice (ILO, 2008) and environmental injustice arises because it is common for vulnerable social groups to live near sources of pollution and hazards (UN HRC, 2018a) and, consequently, to be more exposed to unhealthy environments than the average population (EEA, 2018). The most debated case of territorial injustice is *environmental racism*, in other words, the frequent exposure of racial minorities to risks from waste treatment facilities (Westra and Lawson, 2001).

Territorial injustice is explained by the first "law" of geography: "all things are related to everything else, but close things are more related than distant things" (Tobler, 1970). In fact, most pollutant emissions—air pollution, water pollution, soil pollution, noise, and radiation—are more severe near the source and fade out gradually as the distance from the source increases. Consequently, those living in the vicinity of sources of pollution and hazards are the most vulnerable populations. Several categories of reasons for this vulnerability can be identified:

- economic reasons (cheaper housing in contaminated areas becomes the only affordable option for low-income households),

- educational reasons (groups with low levels of education are unaware of their rights to access to information, public participation, and access to justice),
- cultural reasons (some cultures do not encourage complaining but rather cultivate resignation and the acceptance of inequities),
- institutional reasons (governmental transparency, public consultation practices and wide access to justice are not universally granted), or
- political reasons (minorities have less lobbying power to influence decision-making than other populations do) (Davy, 1997).

Shockingly, the most vulnerable individuals or groups are also less resilient and unable to take self-protection measures (Cutter, 2006). One of the ways to react to locally unwanted land uses (LULUs) (Vanderheiden, 2016), such as those that generate pollution and major hazardous facilities that generate externality costs (such as health risks and loss of property value), is by *voting with one's feet* (Banzhaf and Walsh, 2008). However, abandoning contaminated areas and departing for another location is possible only when the environmental victims have the economic capacity to resettle. If they have insufficient economic capacity but still decide to abandon the polluted area, they will become displaced, which is a fragile condition (HCR, 2001). Consequently, the most economically disadvantaged victims are forced to stay and endure the *slow violence* (Nixon, 2011) of living in an unhealthy environment and being exposed to *structural pollution* (Cole and Farrell, 2006).

4. Legal Identification of GRAFITE Activities

The procedure starts with the identification of GRAFITE activities located in a specific territory. In a sense, the identification of sources of pollution, environmental harm, or environmental risks in the territory is an easy step of the JUST-SIDE method because in most cases, the GRAFITE activities correspond to the "official" lists of activities likely to generate environmental impacts. These lists are included in environmental impact assessment laws that exist in all the countries in the JUST-SIDE network and many other states throughout the world.[1]

[1] These lists are included in environmental impact assessment laws for countries in the EIA Legal Framework. 19 November 2022. https://www.elaw.org/elm/eia-legal-framework.

In fact, those carrying out activities that generate the most serious cases of pollution or environmental risks are generally obliged to perform an environmental impact assessment that identifies and discloses to the public a wide variety of impacts associated with the construction of facilities and the functioning or decommissioning of the activity. Considering the risk of wrongly locating such activities near borders, thus causing transboundary impacts, the Espoo Convention on Environmental Impact Assessment[2] also establishes a list of activities likely to have transboundary environmental impacts.

The following comparative table synthetizes EIA laws in the 10 countries of the JUST-SIDE network[3] plus the 48 parties to the UN Espoo Convention, including countries from Albania to the United States of America.

It must be noted that a category's appearance in the table does not mean that every project in that category is automatically required to submit an EIA. The EIA requirements may depend on the dimensions or location of the intended activity.

The fact that certain activities are not expressly mentioned in a national list does not mean that they can be carried out freely. They may be either forbidden or required to submit a mandatory EIA in accordance with general clauses included in EIA law. These general clauses specify that any project that is likely to cause significant environmental impact due to its nature, dimensions or degree of localization requires a mandatory EIA. Expressly mentioning this requirement in the law facilitates the correct interpretation and application of impact assessment demands.

[2] The Espoo Convention was signed in 1991, entered into force in 1997 and has 48 parties: Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, the European Union, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Montenegro, the Netherlands, North Macedonia, Norway, Poland, Portugal, the Republic of Moldova, Romania, the Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, the United Kingdom of Great Britain and Northern Ireland, and the United States of America. https://unece.org/environment-policy/environmental-assessment.

[3] Argentina, Brazil, Chile, Costa Rica, Colombia, Cuba, Mexico, Portugal, Spain, and Uruguay.

Activities↓	Countries/regions →	Arg	Bra	Chi	CR	Col	Cub	Mex	Por	Spa	Uru	Espo
Airports												
Aquaculture												
Bridges												
Cemeteries and crematories												
Construction in conservation areas												
Dams and water reservoirs												
Dredging												
Fisheries												
Forestry and deforestation												
GMOs, alien species and biotech												
Hospital and health centers												
Hunting areas												
Industrial production*												
Intensive agriculture												
Intensive livestock farming												

Irrigation											
Production of dangerous substances											
Marine outfalls											
Mining and quarries											
Nuclear extractions											
Nuclear power plants											
Oil, coal and gas production											
Oleoducts, gasoducts, pipelines											
Other power plants (fossil fuels)											
Outdoor use of chemicals											
Overhead electric power lines											
Pier construction											
Radars											
Port construction											
Railroad construction											
Road and motorway construction											
Smelters											
Solid waste treatment and disposal											

Slaughterhouses											
Storage of dangerous substances (including CO2)											
Touristic complexes											
Urban and industrial development											
Wastewater treatment											
Water abstraction and recharge											
Water channels, aqueducts, waterways											
Water transfer between rivers											
Wind, solar and geothermal power											

This means that GRAFITE activities can be easily detected and spatialized since they are subject to an institutionalized legal framework that is well known and widespread, therefore reducing difficulties in determining which areas should be identified as possible territorial injustice "hotspots".

5. A Typology of GRAFITE Activities

GRAFITE activities can be classified according to temporal and spatial criteria.

In the temporal dimension, a GRAFITE activity is an "existing" activity if the project or installation is already in operation. The territorial injustice associated with existing GRAFITE activities can be mapped and measured and should be minimized or compensated for. The GRAFITE activity is "new" when there is only an intention to invest in the future development of a project or activity that is likely to cause environmental impacts. The future territorial injustice of a "new" GRAFITE activity can be mapped based on a prospective assessment, if not on actual measurements.

However, such injustice can still be minimized if the activity can be moved to a better location. However, even with a carefully chosen location, territorial injustices can occur later. The reason is simple: the presence of a GRAFITE activity depreciates the commercial value of the surrounding land and built property, making the area more attractive to economically vulnerable persons. This is a second-generation territorial injustice, and compensating for it can be more controversial than compensating for other types of injustice, as the victims have knowingly chosen to move into the vicinity of the GRAFITE activity.

In terms of the spatial dimension, there are two types of GRAFITE activities:

1. "Free" GRAFITE activities without an imperative location that can operate in different locations and
2. "Anchored" GRAFITE activities that are absolutely dependent on a particular location.

"Free" activities can operate in different parts of the territory of a state or region. The environmental impacts of these "free" GRAFITE activities can be reduced or eliminated by choosing less populated areas in which to install "new" activities. For "existing" activities, the alternative is displacing the premises or resettling the neighboring communities. This is the case for waste incinerators, landfills, smelters, cement plants, wastewater treatment plants, roads and hospitals. In contrast, "anchored" activities can operate only in a very precise site because it is where natural resources are located. Examples are dams, mines, quarries, hydrocarbon deposits, and water abstraction, which are strongly dependent on the presence of mineral deposits, hydrocarbon wells, water springs or groundwater.

For "free" GRAFITE activities, the room for maneuvering in impact prevention is much greater than for "anchored" activities.

The sequence of corrective measures to ensure a high level of protection is meant to avoid, prevent, reduce or compensate for negative impacts on the environment.

Thus, when "anchored" activities are being licensed, shifting the GRAFITE location is not an option, and impacts must be mitigated in other ways whenever possible. Territorial injustices stemming from "anchored" activities can be compensated for only by improved access to public services or other benefits that provide better quality of life to the victims.

Table 1 shows possible preventive or corrective measures corresponding to different types of GRAFITE activities.

Space→ Time↓	*Free* GRAFITE activity	*Anchored* GRAFITE activity
	Necessary, appropriate and proportionate measures	
New GRAFITE activity	1. Carefully choose location 2. Use the best available technology that does not entail excessive costs	1. Use the best available technology 2. Relocate the local community 3. Enact compensatory measures OR 4. Simply deny the activity
Existing GRAFITE activity	1. Use the best available technology 2. Relocate the activity 3. Enact compensatory measures	1. Use the best available technology 2. Relocate the local community 3. Use the best available technology 4. Enact compensatory measures OR 5. Phase out activity

Table 1. Measures to prevent or compensate for territorial injustices stemming from GRAFITE activities.

This classification is important for identifying real policy consequences of the application of the GRAFITE method by pointing to legal decisions and instruments aimed at preventing or minimizing environmental impacts. Therefore, the method is more than a descriptive conceptual framework explaining the negative effects of GRAFITE activities; it is also an operational mechanism that focuses on ways of action and reaction to reduce territorial injustices through justice-oriented public policies.

6. Multiple Concepts of Justice

Some core aspects of the JUST-SIDE transdisciplinary methodology that contribute to delivering environmental justice (Rechtschaffen, 2010) and maintaining peace throughout a territory (Soja, 2010) are the multiple

dimensions of justice involved in complex environmental contexts, such as the surroundings of GRAFITE activities.

In this context, two types of territorial injustice must be considered. Absolute injustice happens when the fundamental rights of vulnerable communities (GRAFITE victims) are at stake. Rights enshrined in constitutions and international conventions for the protection of human rights include the right to life, health, rest, property, personal identity, and a home. Freedom of movement and the right not to be displaced for environmental reasons are recent examples of how GRAFITE activities can cause absolute injustice.

Relative injustice (or inequity) arises when GRAFITE victims are more exposed than the general population to serious environmental risk, substantial environmental damage and loss of quality of life.

In addition, the JUST-SIDE network contributes to the achievement of the classic dimensions of environmental justice—preventive justice, distributive justice, restorative justice, and procedural justice (Aragão, Jacobs, Cliquet, 2016).

Each successive step of the JUST-SIDE method embeds one of the justice dimensions and helps eliminate local environmental unfairness associated with GRAFITE activities.

- Step 1. Environmental diagnostic: This step involves accessing environmental information to identify GRAFITE activities and track their environmental impacts on the population. Step 1 rests on the pursuit of preventive justice.
- Step 2. Social diagnostic: This step involves accessing socioeconomic information to map vulnerable social groups that are disproportionately exposed to GRAFITE activities in relation to the general population. Step 2 refers to distributive (in)justice.
- Step 3. Environmental democracy: This step involves public participation using maps to influence and help shape environmental decisions according to the ground truth. Step 3 requires strong procedural justice.
- Step 4. Corrective public policy: This step involves the adoption of justice-oriented measures through public policies to minimize and/or compensate for territorial injustice. Step 4 contributes to the implementation of preventive justice and restorative justice.

The method is based on a feedback loop and the continuous monitoring and assessment of the effects of corrective measures, restarting at step one.

7. Territorial Justice Mapping to Correct Territorial Injustices

Producing multilayered maps can be a powerful tool for communicating with politicians, authorities and decision-makers. The visualization of territorial injustice makes it easier to accept the need to adjust existing public policies or to adopt new, retrospectively oriented policies to compensate for past injustices or to prevent future injustices.

In practice, this means improving public policies with anti-GRAFITE measures for the benefit of current or future GRAFITE activity neighbors. Some examples are wider access to better public services such as health care, water, energy, the supply of food and essentials, public transport, education, culture, and even leisure.

Existing positive discrimination measures to protect vulnerable populations, minorities and the inhabitants of lagging regions can be adjusted to serve as anti-GRAFITE measures. Taxes, subsidies, concessions, quotas, subscriptions, facilitated access to services, and other benefits that are in force in Portugal could inspire the development of anti-GRAFITE measures elsewhere. Some examples are as follows:

- Similar to tax reduction policies for the outermost insular regions, why not enact a reduced VAT for GRAFITE neighbors?
- Similar to tax reductions for real estate located in unhealthy areas, why not enact a lower property tax for GRAFITE neighbors?
- Similar to racial, ethnic, and gender quotas for access to government civil servant posts, why not enact a quota for GRAFITE neighbors?
- Similar to the special quota for access to university for the descendants of emigrants and diplomats, why not provide a green lane for access to university for the children of GRAFITE neighbors?
- Similar to a transport subsidy (social pass) for elderly individuals and students, why not create a transport subsidy for GRAFITE neighbors?
- Similar to scholarships granted to high-performing but underprivileged students, why not create school scholarships for GRAFITE neighbors?
- Similar to the minimum income allowance for disabled people, why not implement a minimum income scheme for GRAFITE neighbors?
- Similar to the facilitation of access to public services for firefighters, blood donors, vaccine volunteers, etc., why not create easier access to public health services for GRAFITE neighbors?

- Why is there no regional preference for access to higher education institutions? Why is there no tax discount when buying an electric car? Why are there no subsidies for energy efficiency and renewable energy use at home? Why are there no special pricing policies for basic supplies such as water, energy, and internet?
- Why not offer transport upon request from the interior of the country to cities when GRAFITE neighbors need to access public services? Why are there no highways that do not require tolls near GRAFITE activities? Why are there no subsidies for the installation of civil protection systems at home?

The last step of the JUST-SIDE method is a set of procedures for monitoring and assessing the merits of public policy measures adopted to mitigate or compensate for the territorial injustice of GRAFITE activities, including returning to the first step and performing new diagnoses. These merits depend on the justice, effectiveness and efficiency of the corrective measures.

From a legal point of view, anti-GRAFITE measures are fair when they do not cause unwanted side effects or, if they do, when the effects are evenly distributed throughout the territory.

From a management point of view, anti-GRAFITE measures are effective when the desired mitigation or compensation results have actually been achieved and when these results are proportionally distributed throughout the territory.

From an economic point of view, anti-GRAFITE measures are efficient when the benefits of public policies justify the costs and when the revenue to support the costs is collected fairly throughout the territory.

8. Geospatial Knowledge for Territorial Justice

The global use of new technologies for sustainable development was expressly recognized in 2018 when the General Assembly of the UN adopted a resolution declaring that the Economic and Social Council should focus on "future trends and scenarios related to the (…) contribution of new technologies, in the economic, social and environmental areas on the realization of the Sustainable Development Goals" (UN HRC, 2018b).

In 2013, the UN secretary-general appointed a high-level panel of experts to advise on the post-2015 agenda. In the view of the panel, "better data and statistics will help governments track progress and make sure their decisions are evidence-based; they can also strengthen accountability (…). A true data revolution would draw on existing and new sources of data to

fully integrate statistics into decision making, promote open access to, and use of, data and ensure increased support for statistical systems (…) data gathered will need to be disaggregated by gender, geography, income, disability, and other categories, to make sure that no group is being left behind" (HLP, 2013).

The Agreement on Access to Information, Public Participation and Access to Justice in Environmental Matters in Latin America and the Caribbean Region (Escazu, 2018) proclaims that "each Party shall guarantee that environmental information systems are duly organized, accessible to all persons and made progressively available through information technology and georeferenced media, where appropriate" (article 6 no. 3).

The UN Human Rights Council calls upon states "to collect disaggregated data on the effects of environmental harm, including the loss of biodiversity and the decline of ecosystem services, on persons in vulnerable situations" (UN HRC, 2017).

When social and environmental data are georeferenced, processed, interpreted and presented in maps, they can help identify information gaps and visualize (Carter and Herold, 2019) sustainable development indicators (Moreno-Pires, 2014) and territorial injustice much more clearly than the use of graphics or tables. Mapping tools that display layers of georeferenced statistical information (Jankowska and Pawelczk, 2014) from social and environmental datasets help visualize (Krieger, Dorling and McCartney, 2012) and understand territorial injustice. Advanced technologies, such as satellite imagery and geospatial intelligence, are already being used in the context of the Food and Agriculture Organization of the United Nations to support decision-making and promote multidisciplinary approaches to sustainable development (FAO, 2006).

In the Anthropocene era, an interdisciplinary approach is essential to understand the complex reciprocal relationships and interdependencies between humans and the earth.

In the context of the social sciences, law is a transformational science that relies on other areas of knowledge to build a more accurate view of the social and environmental reality and formulate judgments about the legal desirability of this reality and visions of the desired future.

The adoption of scientifically informed laws that are based on scientific data, oriented toward objectives validated by science and guided by ecologically coherent principles increases the social acceptability of legal rules and helps improve the effectiveness of law as well as the legal certainty, justice and sustainability of development options.

Hence, it is important to encourage the development of innovative methodologies to increase the effectiveness of environmental law.

What are the benefits of visualizing territorial injustice?

- Doing so aids in identifying and avoiding environmental and social regression.
- Doing so helps policymakers choose the best public policy options to fight territorial injustice.
- Doing so allows us to design laws with greater transformative potential.

Using maps to visualize territorial justice is essential for the transition to a circular and carbon-neutral economy, to a society that lives within the limits of the planet and in harmony with nature, and to an improved ecological status that becomes part of our lives and can be part of the lives of future generations.

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