

Urban Planning for Climate Change: Mendoza City and the Piedmont

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Keywords	climate change equity, multi-level governance, ecological restoration
City Population	115,041
City Area	106.07 km ²
City GDP	28.7 billion USD
Climate Zone	BWk (cold desert)
ARC3.3 Linkages	Governance, Enabling Policy Environments, and Just Transitions

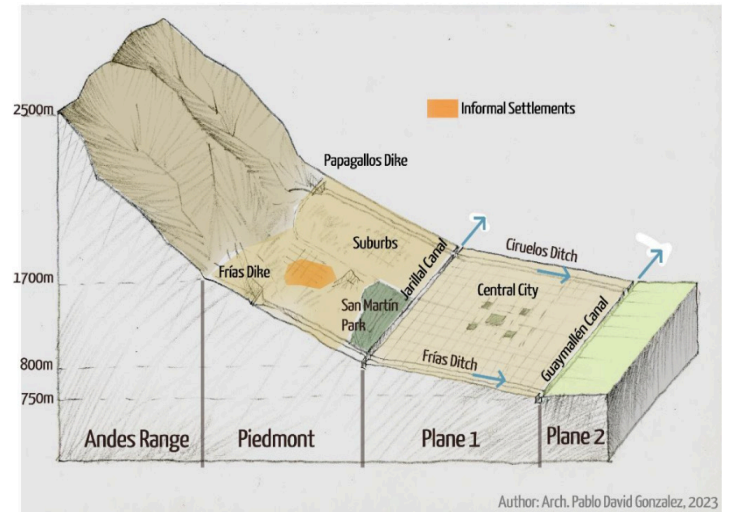


Figure 1. Mendoza topography, ecological areas, and urban landscape

Source: Pablo Gonzalez 2023

Mendoza-Piedmont Context. Located in an arid region at the foot of the Andes, Mendoza occupies the entire west plain and extends into the Piedmont (Fig. 1). The Piedmont serves as a link between the mountain and the plain and covers an area of 1,200 km². This fragile ecosystem, characterized by steep slopes and seasonal waterways, has been significantly affected by climate change, resulting in flooding and erosion that threaten its ecological integrity. The upper Piedmont comprises a natural terrain at 1,150 meters above sea level, alongside a transition zone where natural and urban features intersect (Abraham, 2005). Its proximity to the city center, low land costs, and unique availability of vacant land in the city make it a prime target for urban expansion.

Unplanned urbanization is a leading cause of transformation and exacerbates environmental degradation and risks. Expanding urban areas contribute to distinct socio-economic challenges. While some of the urban poor live in public housing projects, many are found in highly vulnerable situations, living in informal settlements, or scattered along waterways. Affluent populations have been developing suburbs with gated communities that have grown rapidly since the 2000s and are encroaching on natural environments.

Climate Hazards and the Piedmont. Due to both climate change and unsustainable human activities, the city will experience more frequent and severe natural disasters such as floods, storms, hailstorms, and alluvial events. Additionally, there will be an increase in drought and desertification, as well as changes in water systems due to reduced snowfall, glacial retreat, and melting (MCM, 2023). Moreover, the rising temperatures, heat waves, increased solar radiation and

greater risk of wildfires will be intensified by socio-environmental hazards (Boninsegna, 2014). These will impact the Piedmonts' areas in different ways. The more natural areas are expected to experience ecosystem degradation and a shift in ecological niches, as well as water stress and changes in hydrological cycles, leading to a higher risk of wildfires. The transitional zone could face socio-ecological impacts linked to natural and human-induced fires, water scarcity, reduced livelihoods, degraded natural drainage systems, and altered hydrological functions, resulting in frequent floods, social strife, and escalating inequality (MCM, 2023). Unplanned urban expansion has contributed to desertification processes and socio-economic disparities. Land cover change, soil compaction, and sealing exacerbate the impacts of climate change, and the lack of basic and climate-resilient infrastructure contributes to land degradation (Fig. 2).

Multilevel Governance and Planning. Since the late 1980s, provincial laws have attempted to preserve the ecological system by regulating the anarchic occupation of the Piedmont. Mendoza was the first province in Argentina to sanction a Land Management regulation ([Law Number 8051, 2009](#)) and to develop a Provincial Land Management Plan ([Law Number 8999, 2017](#)). In 2022, the Management Guidelines and a Specific Program of Sustainable Planning of the Foothills and Piedmont Area were developed ([Law 9.414, 2022](#)). These policies share a comprehensive

environmental approach to controlling degradation, improving environmental conditions, and rationally managing the urbanization of the Piedmont.

The metropolitan governance started in 2016 with the Policy Coordinating Council for the Metropolitan Area (UNICIPIO). This interjurisdictional body developed the Action Plan for the Metropolitan Area that addresses the main socio-environmental issues of the Piedmont. In 2022, the provincial government established the Interjurisdictional Unit of the Piedmont (UIP), composed of the municipalities that have jurisdiction over it. It is aimed at reconciling conservation and territorial development by regulating human activities and preserving the environmental function of the territory, using strategies that mitigate impacts and consider existing and future risks (GdM, 2022).

In recent years, the city of Mendoza has developed planning instruments for the Piedmont through the Mendoza Land Use Plan (MCM, 2019) and the Urban Building Code (2019). In 2020, the city enacted the Declaration of Climate Emergency in the City of Mendoza ([Decree No. 95/2020](#)), which established the goal of achieving a positive climate management balance, increasing absorption and reduction of greenhouse gases by 2030. The Climate Emergency Local Climate Action Plan (2020), later updated by the Climate Change Action Plan (2023), proposed to develop instruments to protect and restore the Piedmont while enhancing the adaptive capacity of vulnerable populations.

The city integrates a multilevel governance structure comprised of different local and federal agencies with public and private universities, private sector entities, and civil society to assess risks and co-generate knowledge and solutions. Mendoza also belongs to several national and international cities networks.

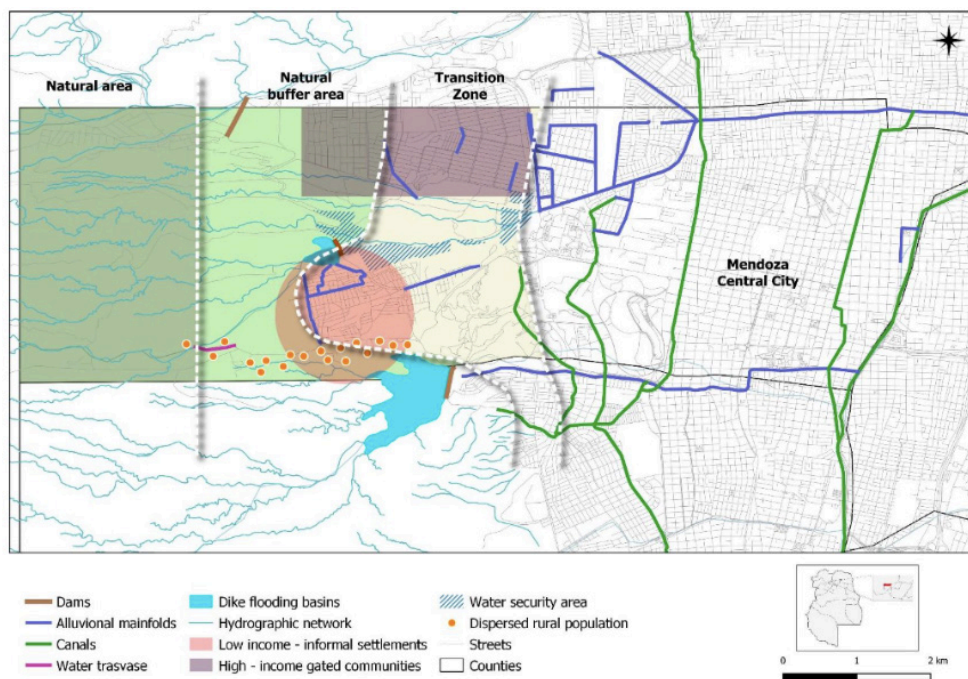


Figure 2. Mendoza Piedmont areas, urbanization patterns and infrastructure

Source: Daniela Grifonni

Planning and Strategies in the Piedmont. The local authority addresses the diverse landscapes of the Piedmont with integrated and targeted strategies (Fig.2). These strategies consider land management, water and living resources to promote the sustainable use of the Piedmont and to prevent climate change effects and risks. They implemented climate change adaptation and mitigation measures by establishing protection zones (MCM, 2019), promoting social equity, ecosystem services restoration (MCM, 2023), and control of the urban expansion in the foothills by adopting a more efficient urban design (MCM, 2019). This study outlines four main issues: protection of natural areas, land uses, and adaptation for residential urban expansion, the vulnerability of the urban poor, and ecological restoration (Fig. 2). The first two issues relate to current regulations, and the other two to projects that are under implementation (Fig. 3).

i) Protection of natural areas

The land use plan considers the level of protection based on the environmental features and hazards and establishes specific uses and restrictions. The areas with higher levels of environmental protection are those closer to the Andes, with natural preponderance (Fig. 2). The Natural Zone has the least human impact with the highest protection level. The second zone is the Natural Buffer Zone, which predominates the Piedmont ecosystems, serving as a connection between natural environments and urbanized areas. Moreover, given that water management is crucial to mitigate risks, especially flash floods in the Piedmont, the zoning ordinance establishes a dike flood zone and a water security area in the transition zone. All these areas prioritize scientific activities, conservation efforts, recovery initiatives, monitoring, and environmental education,

allowing very specific additional activities according to the degree of naturalness and level of risk (MCM, 2019).

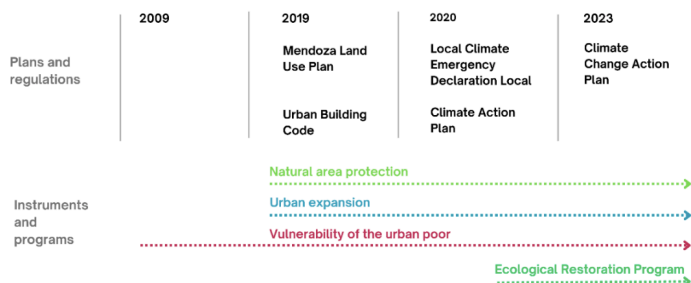


Figure 3. Plans and projects implementation timeline

ii) Land uses and adaptation for residential urban expansion

The Piedmont residential area is mainly composed of low density suburban areas. These private developments are not adapted to the environment and landscape, resulting in high levels of water runoff to lower-lying settlements. Consequently, zoning ordinances establish parameters for the urban layout that include adaptation to the shape of the terrain, such as roads parallel to the contour of the topography, the preservation of the natural drainage network, the sealing of the riverbed, and the use of infiltration systems to contain the excess of rainwater (MCM, 2019). They also consider soil fixation through planting trees with adapted species to prevent erosion, avoid open spaces without vegetation cover, and promote the design of retention green areas such as floodable squares.

iii) Vulnerability of the urban poor

Successive programs have addressed the problems of the urban poor in Piedmont and have recently been incorporated into urban plans and regulations. Since the 1940s, the urban poor have been living in informal settlements with precarious housing conditions that expose them to multiple risks. To reduce their vulnerability, local authorities, in coordination with other levels of government, have been implementing specific projects in La Favorita and surrounding communities since 2010.

From a multidimensional approach, the projects aim to integrate these settlements with the city and to improve habitat conditions by providing access to basic services and infrastructure, public space, and property rights to ensure homeownership. Additionally, the projects have included access to social services such as education and health, among other benefits.

In recent years, they have also incorporated environmental measures to improve the quality of life and mitigate climate risks by building alluvial works (adaptation to climate change), incorporating native forestation with low water requirements, and efficient irrigation systems to increase air humidity and reduce the urban heat island effect. These projects received international funding from The World Bank and the Inter-American Development Bank for implementation.

iv) Ecological restoration

The Ecological Restoration Program proposes to stop the degradation of soil and natural environments, and promote ecosystem restoration by strengthening the provision of ecosystem services and adopting measures through nature-based solutions and carbon capture projects to mitigate climate change in the Piedmont (MCM, 2019; Segura et al., 2023). This local initiative developed public-private partnerships and received funding from the [GEF7 Sustainable Cities](#) program.

The multidisciplinary team in charge of performing a multicriteria assessment to prioritize restoration areas includes universities, public institutions, NGOs, and neighbors. The aim is to improve ecosystem quality by re-establishing connections between fragmented habitats, and identifying potential restoration areas to increase the extent of native vegetation cover and wildlife habitat through passive and active restoration. Passive restoration allows natural regeneration to occur by eliminating degradation factors, working in patches with good conservation conditions that allows the seeds to disperse and recolonize the area.

Active restoration involves direct human intervention on the structure of the ecosystem to accelerate the process of ecological succession through the introduction of native species that have not been able to recover on their own (Segura et al., 2023). Both types of interventions are being implemented by the city, through pilot projects, with the participation of different actors, neighbors, universities, and local entrepreneurs (Fig. 4).



Figure 4. Ecological restoration intervention in Mendoza

Changes and Challenges. These initiatives have had a positive impact on the environment, reduced risk, and promoted equity. The development of natural areas and ecological restoration has contributed to the preservation of vital natural areas in the Piedmont, creating protective buffers, preventing risks of alluvial deposition, and limiting land use changes. However, the small scale of the ecological restoration interventions is not sufficient to mitigate the effects of climate change. Consequently, scaling up these

projects represents an important challenge for adaptation.

The expansion of the Piedmont's ecological restoration strategy is a great opportunity to address integrated environmental solutions at the physical, biological and social levels. Social aspects include community participation, the strengthening of green economy strategies and community empowerment, the development of small-scale agro-ecologies, native tree nurseries, participatory restoration mechanisms, measurement, and monitoring. On the other hand, a restored ecosystem, with community participation, creates a barrier to high impact / undesirable uses in the area.

Environmental regulations have been applied through incentives for adaptation, conservation, and sustainability, or sanctions for real estate development, illegal dumping, and deforestation. However, implementing accountability is often limited due to the high pressure to expand the urban area into the Piedmont. Local governments face challenges in exercising adequate control due to limited economic and technological resources. Addressing the vulnerabilities of the urban poor has evolved over time, incorporating new perspectives that combine equity, social justice, environmental sustainability, and resilience. The implemented strategies have ensured land security access to basic services, improved habitat conditions, and reduced environmental and climate risks.

There has been an advancement from planning to project implementation throughout the timeline in the climate and environmental agenda. Furthermore, various stakeholders participate in this agenda, including public and private sectors, universities, NGOs, and community members.

Conclusions. This case exemplifies the significance of urban planning in mitigating and adapting to the impacts of climate change, including the challenges related to addressing environmental issues that intersect multiple jurisdictional boundaries. Despite the development of a comprehensive multi-level governance structure, there is a need for enhanced coordination among the urban centers located in the Piedmont of the metropolitan area.

At the metropolitan level, Mendoza has very solid environmental governance mechanisms, the UNICIPIO and the UIP. This represents a window of opportunity and a great challenge to strengthen collaboration between both bodies, which would contribute to better management of such a complex and significant environmental entity. The other key challenge is related to the limited local and global funding available, which is needed to scale up and implement adaptation policies in the Piedmont.

Mendoza provides an example to address climate change in an arid region. It illustrates a pathway to transformation by integrating mitigation and adaptation through ecosystem-based solutions supported by urban planning. It also applies a multilevel governance structure to co-generate knowledge that enhances the policy implementation process. Furthermore, these policies are novel in that they address urban inequalities among vulnerable populations in developing countries by integrating climate change and sustainable development objectives.

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Acknowledgments

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Additional Data

- **Population Density:** 2,055.4 people/km²
 - **Per Capita Gross National Income (GNI):** 13,440 USD (Higher-Middle Income) [2024]
 - **Gini Coefficient:** 42.4 [2023]
 - **Human Development Index (HDI):** 0.865 (Very High) [2023]
 - **Type of Climate Intervention:** Adaptation
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