# Urban Arid Green

## A Nature-Based Solutions Proposal for Ecocity Development in Arid Regions. Case Study Tamansourt, Morocco

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# Chapter 7
# Urban Arid Green: A Nature-Based Solutions Proposal for Ecocity Development in Arid Regions. Case Study Tamansourt, Morocco

**Rosa de Wolf, Nico Tillie, Rob Roggema, and Kristel Aalbers**

**Abstract** Drylands, hyper arid to subhumid areas where rainfall is limited, are expected to expand due to climate change. Natural resources, such as water and food, are scarcer in these areas. Population growth and urbanization are putting even more pressure on communities living there, as well as on the urban fabric and ecosystems. How can nature based ecocities be created in these environments?

A pattern language, which is able to translate practical knowledge into substantiated spatial configurations that work in arid areas is missing in current theory and practice. The ´Urban Arid Green research by design project´ addresses a sustainable population growth and urbanization in arid regions via the case study in Tamansourt. Tamansourt is one of the 19 Moroccan new towns developed under the national Villes Nouvelles (New Towns) strategy. The city is still under construction, as the spatial analysis, site visit, and conducted interviews have revealed. The city has not reached its target population nor its desired level of urban activity yet. However, fundamental issues already manifest themselves.

The vision 'Regreen to Rewild' aims to counteract the pressures mentioned before, by developing a transformative framework towards an ecocity, taking the natural system as the basis (nature-driven urbanism). Tamansourt Ecocity gives purpose to the local community and a new identity to the city.

The transition described in this vision requires a systemic change, including environmental, policy and behavioral change. To support this shift, a common language amongst all future stakeholders has been created: the Urban Arid Green pattern language. This spatial language includes four pathways, of which each includes a group of development guidelines. One of the four pathways captures the original

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design guidelines for Moroccan new towns, as formulated by Al Omrane in 2010. The other guidelines focus on the biosphere, the urban fabric, and immaterial values.

The Urban Arid Green project shows how these generic patterns can be translated into a site-specific design which stakeholders can use in the city's transition. This sets a precedent for other arid cities that aim to sustainably develop while under the pressure of scarce resources, climate change and population growth. Every landscape needs to adapt its own site-specific pathway based on the generic language, allowing unique dialects for different landscapes.

**Keywords** Ecocity · (un)sustainable growth · Aridity · Natural resources · New towns · Spatial nature-based solutions · Pattern language

## 7.1 Introduction

The global population is growing, projected to increase from 7.7 billion in 2019 to 10.9 billion by 2100 (Maja and Ayano 2021). Cities today face significant challenges due to this growth, with the largest increase expected in low-income countries where societies are more dependent on natural resources. This population surge, coupled with urbanization and economic development, escalates the demand for food, water, and energy. Drylands (Fig. 7.1) range from dry subhumid to hyper-arid areas. Currently, over two billion people live in drylands, which are expected to expand due to climate change (Rajaud and Noblet-Ducoudré 2017).

Many economies in arid regions rely heavily on agriculture, but climate variability threatens crops with excessive, insufficient, or untimely rainfall (Keeton and Provoost 2019, p. 34). The increasing demand for irrigation increases water

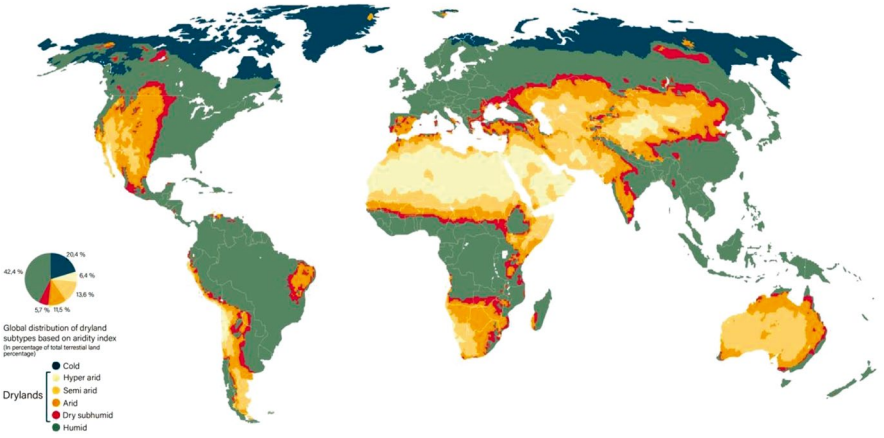



**Fig. 7.1** Global distribution of dryland subtypes based on aridity. (World Atlas of Desertification n.d.)

insecurity (Hill and Pimentel 2022). These arid areas already suffer from limited access to natural resources, particularly water. Consequently, the overall wealth and health of societies in drylands are lower than those in more humid areas (Rajaud and Noblet-Ducoudré 2017). The African continent, especially its northern region, is predominantly covered by drylands.

Urbanization and population growth worldwide create spatial challenges in cities, which can be addressed by densifying or expanding existing cities or building new urban settlements. These so-called New Towns are found in many countries, particularly in rapidly urbanizing Africa, which experiences significant population and urban growth. However, many new towns in Africa, are vulnerable to climate variability and climate change (Keeton 2020). Moroccan new towns face serious desertification risks (Fig. 7.2).

Morocco's rapid population, urban, and economic growth has drastically changed its urban landscape, leading to a housing shortage. To manage uncontrolled urbanization and support economic growth, Morocco implemented the Villes Nouvelles strategy, founding nineteen new towns (Côté-Roy and Moser 2022). The geographical distribution of these towns is shown in Fig. 7.3.

Tamansourt, Tamesna, Lakhyayta, and Chrafate are the first-generation satellite new towns, established between 2004 and 2009 (Côté-Roy and Moser 2022, p. 34). Building a new urban structure from scratch is a long-term process, meaning these cities do not immediately meet all demands. After 20 years, it's time to evaluate

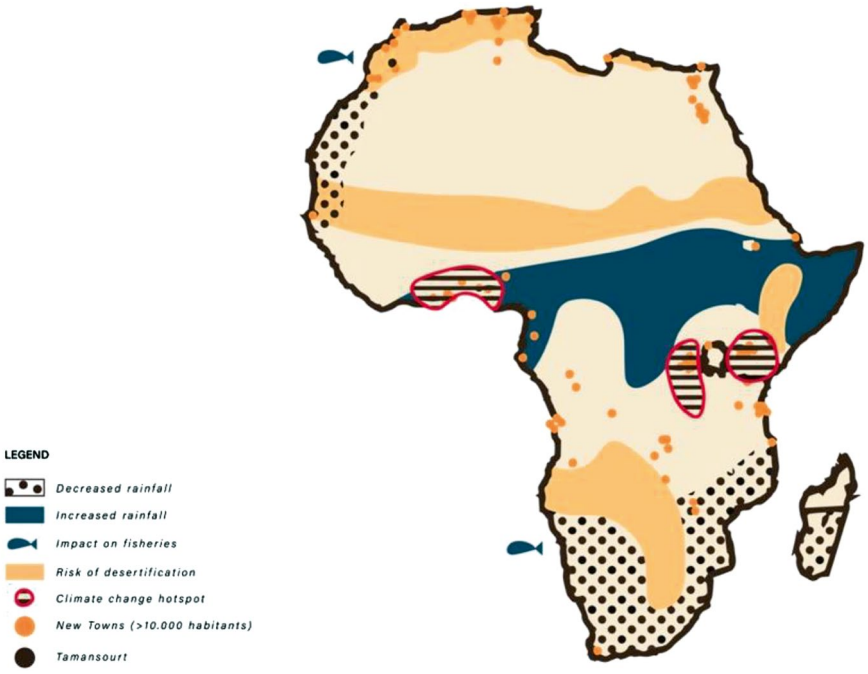



**Fig. 7.2** Climate change threats Africa. (Keeton 2020, p. 44) adjusted by author


**Fig. 7.3** Geographical distribution of new cities in Morocco. (Côté-Roy and Moser 2022, p. 30) adjusted by author

these first-generation new towns. The first-generation new towns are designed as satellite cities, and there is now an aim to transform them, along with three other towns, into ecocities. This transformation project is led by Al Omrane, the state company that developed these cities (Ecocity Morocco n.d.).

Tamansourt, established in 2004 to prevent overpopulation and congestion in Marrakech, stands out for its large area and target population of 450,000 inhabitants. Tamansourt's landscape is the most barren (Fig. 7.4). Located in the Tensift Basin, the area faces limited groundwater and surface water availability, with occasional stark seasonal contrasts of heavy rainfall and extreme droughts (Fniguire et al. 2014; Abdelaziz et al. 2022).

People moved to Tamansourt for better access to urban amenities and job opportunities. However, despite a focus on social and affordable housing, the city lacks adequate job opportunities and urban amenities such as public transport. The goal was to create a low-density, green city with a harmonious mix of residents, but Tamansourt, called a dormitory city, has not yet achieved these goals. Tamansourt's target density of 23100 inhabitants/km$^2$ (Côté-Roy and Moser, 2022, p. 30) exceeds the by UN-Habitat considered ideal density of 15000 inhabitants/km$^2$ (Keeton and Provoost, 2019, pp. 92, 111). Tamansourt is located 10 km northwest of Marrakech, separated by the Tensift River (Fig. 7.5). The Marrakech-Safi highway allows a 15-min commute by car. Many residents commute to Marrakech for daily activities.

Over time, Tamansourt's land degraded. Aerial views from 1985 to 2021 show the disappearance of green wadi structures (Fig. 7.6), now functioning only as

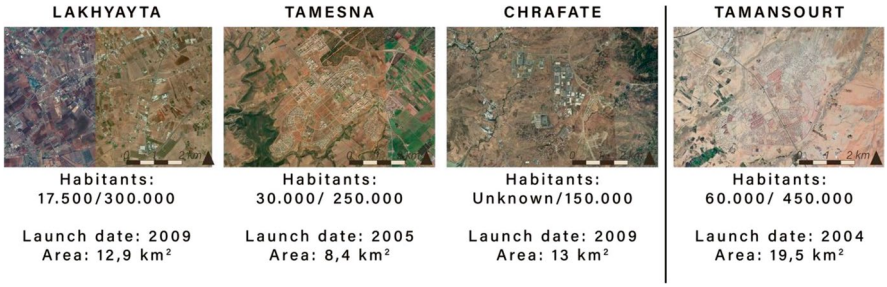



**Fig. 7.4** Comparison between first generation of New Towns. Images retrieved from (Google Earth Pro 2022), facts from (Côté-Roy and Moser 2022, p. 30)


**Fig. 7.5** Schematic situation of Tamansourt

erosion gullies. The landscape and ecosystem degradation coincides with the city's focus on built environment development.

As Tamansourt densifies further, unsustainable development could exacerbate degradation. Transforming Tamansourt into an ecocity, as proposed by Al Omrane, requires spatial redevelopment. This chapter examines how the ecocity principles can be translated into a spatial design that fosters sustainable interactions between human and natural systems. Tamansourt had a notable population of young children

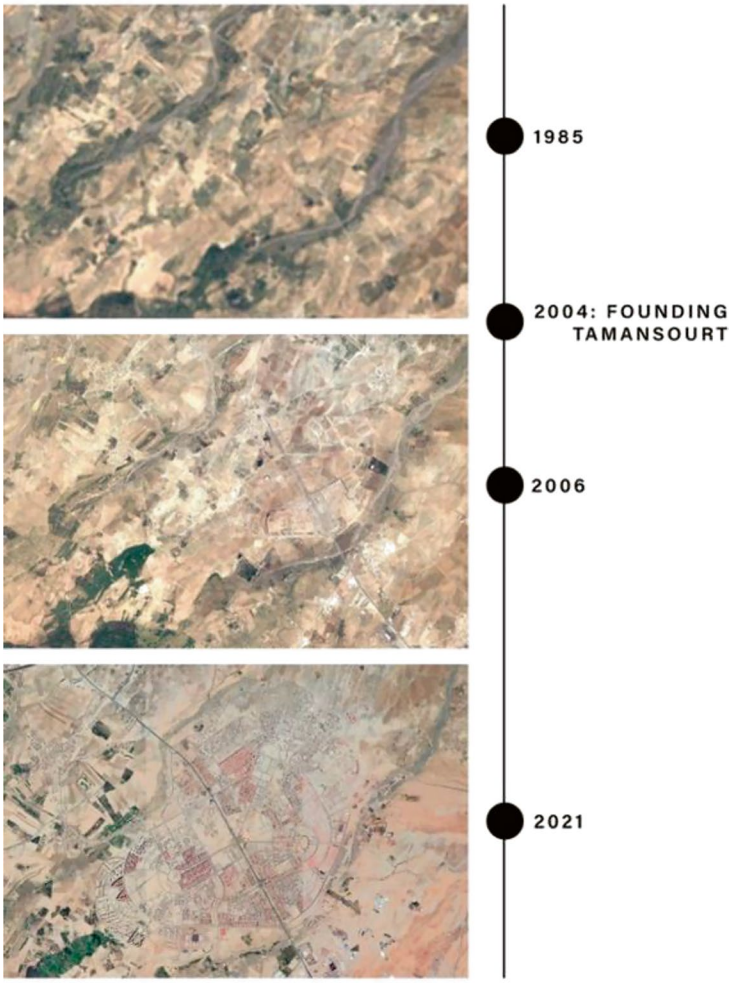



**Fig. 7.6** Timeline development site of Tamansourt. (Images retrieved from Google Earth Pro 2022)

in 2015, indicating large families. The median age was 24.6 years, with a nearly equal gender ratio (City-facts n.d.). Tamansourt aims to accommodate demographic growth, control urban sprawl, and stimulate economic revival. The town is designed for low-density living with a variety of housing types to meet diverse needs (Abdelaziz et al. 2022).

As in most Islamic towns, clear sightlines to the mosques result in predominantly low-rise buildings in Tamansourt. This aimed target population leaves little open public space, which currently is mainly occupied by wide asphalt strips for traffic. Unlike traditional Moroccan towns, Tamansourt lacks historical layering. The city's current construction status shows finished areas and ongoing development, with limited activities and job opportunities, mostly in the construction sector. Future

plans include a university campus, an industrial site, and more social housing, aiming for a diverse social and economic mix. Tamansourt is located in the Tensift Basin, prone to soil erosion and land degradation. The arid and rocky soil, combined with a lack of vegetation, exacerbates water runoff and soil loss, leading to flooding and droughts. To address these issues, urban design must focus on land conservation and soil restoration. Morocco faces a severe water shortage, expected to worsen by 2030. The Green Morocco Plan has enhanced agricultural output but increased social inequalities and dependency on unpredictable rainfall. Generation Green 2020–2030 aims to modernize traditional farming and improve resilience to climate change. Sustainable agriculture is essential for soil and water conservation.

Vegetation significantly cools the urban environment and improves residents' mental and physical health. The IUCN recommends integrating more native species to enhance ecosystem services like these (Ecocity Builders 2022). Public green spaces are crucial to Tamansourt's vegetation coverage, as there are limited private gardens with this predominantly social housing stock. Tamansourt's design must prioritize sustainable development by incorporating more vegetation and focusing on land and water conservation. This approach aligns with Al Omrane's vision and the Ecocity Builders' framework and standards (AL Omrane Marrakech 2008; Ecocity Builders n.d.), promoting a comfortable urban climate and resilient infrastructure.

## 7.2 Objective

**As a long-term objective,** Tamansourt will have been transformed into an ecocity by 2040, and shifted from environmental degradation to ecological restoration. The city leverages nature to foster sustainable development, with active regreening allowing the landscape to regenerate and rewild (Fig. 7.7). This transformation creates a balanced urban landscape where nature, agriculture, and human activities coexist, contributing to a resilient, healthy biosphere. New opportunities arise through plant nurseries, ecotourism, and agrotourism, fostering economic and social independence. Training and employment programs ensure that residents actively participate in this transition, promoting a sustainable economy.

The ecocity concept extends beyond Tamansourt, inspiring regional rewilding and reversing desertification. The transition focuses on closing essential loops, particularly in water management and local food production. A circular water system is established, using treated wastewater to restore soil quality and support vegetation. Tamansourt becomes a testing ground for innovative agricultural practices, functioning as a botanical garden with educational tourism. Central and local hubs produce seedlings for regreening efforts, involving residents in the greening process. The city plans to regreen its wadis, creating recreational spaces and additional water sources.

The ecocity transition enhances Tamansourt's economy, diversifying from construction to sectors like tourism, agroforestry, and education. Key locations and


**Fig. 7.7** Regreen to Rewild: Tamansourt Ecocity 2040

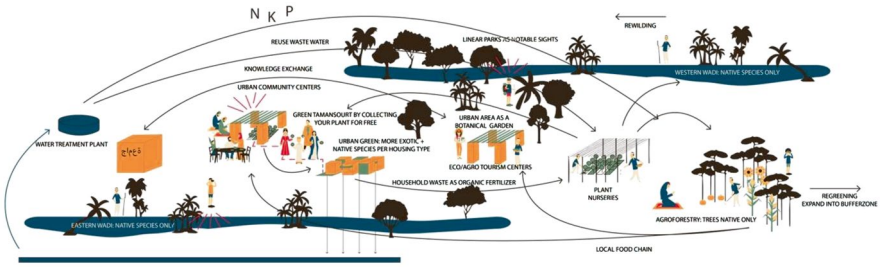



**Fig. 7.8** Close the Loops

hubs stimulate systemic change, spreading to the region between Tamansourt and Marrakech. For a sustainable future, Tamansourt must optimize resource use and rethink its interaction with nature, focusing on water retention through vegetation (Fig. 7.8). The transformation involves a circular water system, top-down support from relevant ministries, and active local participation. Empowering private actors and residents ensures the city's self-sufficiency and financial sustainability.

Community involvement is crucial, with education and awareness programs to promote environmental stewardship. Engaging universities, developers, and local farmers in the transition fosters a trust-based partnership for a sustainable Tamansourt ecocity.

It is crucial to train local farmers in agroforestry techniques and to develop a tourism program that integrates eco- and agrotourism activities. In addition to training, it is essential to create employment opportunities in these sectors. Both short-term and long-term successes are necessary for sustainable urban development. By 2040, the local community envisions living in an ecologically healthy city, enhancing livability and comfort. In the short term, immediate rewards such as income generation and increased green spaces are also pivotal. Initially, a combination of

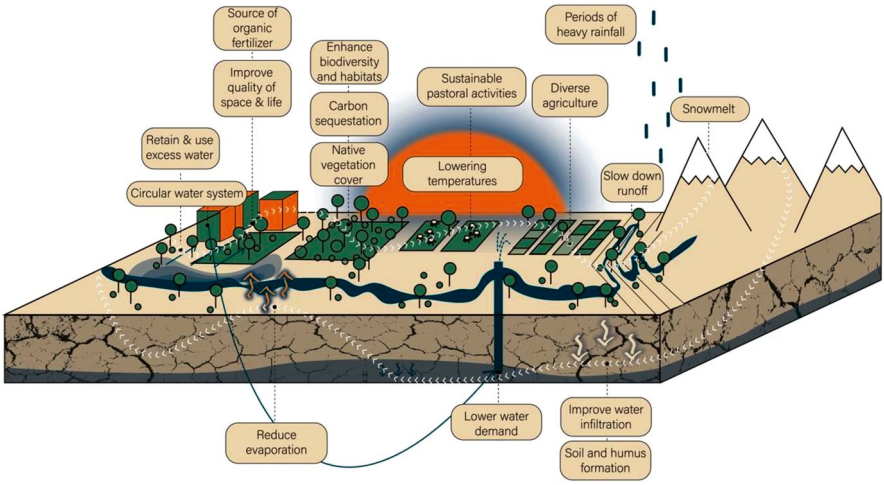



**Fig. 7.9** Environmental change

incentives and regulations may be required to ensure that human activities do not disrupt the natural environment and allow for ecosystem recovery (Fig. 7.9).

## 7.3 Approach

This chapter searches for an approach wherein urban design can contribute to solving the hereabove named problems by sustainably addressing population growth and urbanization in arid areas.

Sustainable urbanization can take place when the spatial condition for agglomeration, accessibility and quality of life are considered (Ram and Gerretsen 2014) (Fig. 7.10). Taking these spatial conditions as a driver in the design of the urban landscape, economic developments can be further stimulated while strengthening the competitive position of the site.

In 2015, the 2030 Agenda for Sustainable Development was launched, providing a globally shared master plan for sustainable development specified in seventeen Sustainable Development Goals (SDGs). These goals serve as a global call to action for building peace and prosperity (UN 2015). The Stockholm Resilience Centre (2016) integrated the SDGs into a ´wedding cake model´ in which the biosphere functions as the foundation for society and the economy and is therefore essential for achieving global sustainability (Stockholm Resilience Centre 2016). When designing for sustainable urban development, this biosphere should be recognized as the basis. Landscape-based urbanism is "a multi-scale planning and design approach for developing resiliency and adaptive capacity by creating flexible, strong socially and ecologically inclusive landscape structures, connecting long-term

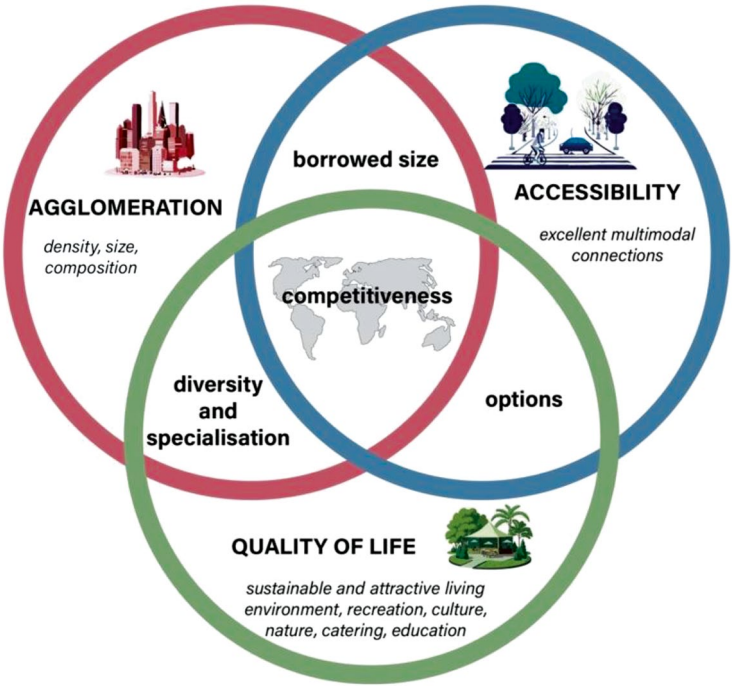



**Fig. 7.10** Coherence between agglomeration power, accessibility, and quality of life, (Ram and Gerretsen 2014). Translated and adjusted by author

perspectives with short-term interventions using research through design as way-finding in a transdisciplinary process." (Nijhuis 2022, p. 251; Roggema 2020), The concept of the ecocity aligns with this landscape-based urbanism approach. Ecocity Builders (2010) define an ecocity as "a human settlement modelled on the self-sustaining resilient structure and function of natural ecosystems. An ecocity provides healthy abundance to its inhabitants without consuming more (renewable) resources than it produces, without producing more waste than it can assimilate, and without being toxic to itself or neighboring ecosystems. Its inhabitants' ecological impact reflects planetary supportive lifestyles; its social order reflects fundamental principles of fairness, justice, and reasonable equity."

These concepts form the backbone of the conceptual framework of the Urban Arid Green project (Fig. 7.11), which sustainably addresses population growth and urbanization in arid areas as a systemic solution to global sustainability. It presents urban development as a key driver affecting all linked systems within the landscape, including socio-cultural, biological, and physical layers. By building with nature, the Urban Arid Green project interlinks the productive landscape, urban area, and waterscape with these systems, aiming to create great, fair, and resilient places that form an ecocity. When ecocities work together as a network, they contribute to

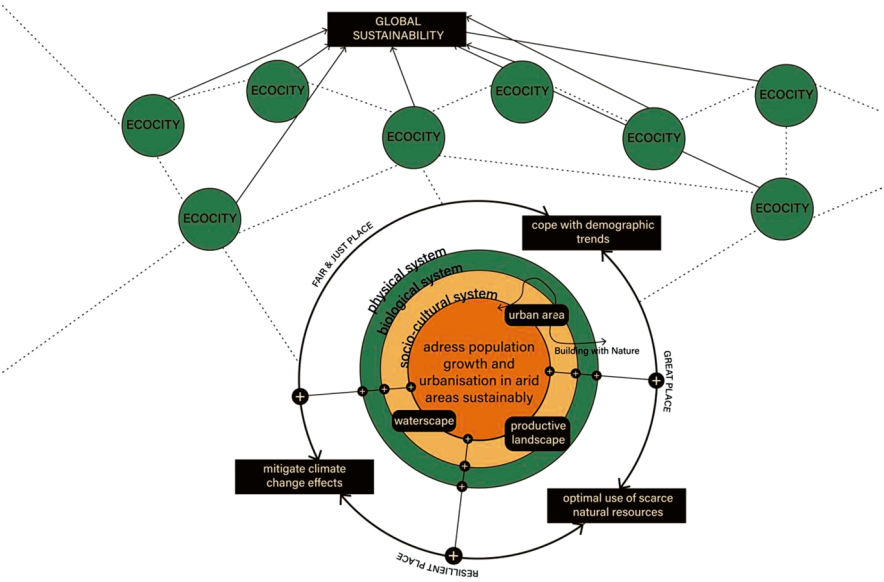



**Fig. 7.11** Conceptual framework Urban Arid Green

global sustainability by coping fairly with demographic trends, mitigating climate change, and optimizing the use of scarce natural resources.

The Urban Arid Green project aims to demonstrate how the demand for housing and natural resources can complete rather than compete. Urban Arid Green seeks to integrate human, natural, and agricultural activities in urban areas, focusing on arid regions to support growing societies facing resource disparities. Tamansourt, like many arid new towns, faces significant challenges. The project envisions an ecologically healthy and vibrant Tamansourt by reversing the destruction of the natural system. Tamansourt will be used as a case study to formulate and test guidelines for designing with limited natural resources, serving as an example for other new towns in arid regions when generalizing the process for applicability to these other locations. This holistic approach aims to counteract the growth of arid areas and desertification while mitigating climate change. Based on the analysis and dialogues on-site, a vision for Tamansourt, "Regreen to Rewild, Tamansourt Ecocity 2040," has been designed, drawing on Al Omrane's original vision and the Ecocity Builders' principles. The planned built volumes are retained, with systemic environmental, policy, and behavioral changes needed for this transition defined. Given that many cities face similar pressures from climate change, population growth, urbanization, and scarce resources, a strategy useful for other cities is developed. The Urban Arid Green pattern language is formulated, incorporating guidelines by Al Omrane (2010) and additional pathways: Circularity & Ecology, Supportive Lifestyles, and Facilitating Fabric. These socio-spatial guidelines focus on supporting the transition into an ecocity. Validation of this pattern language via a design exploration in

Tamansourt sets an example for other urban arid landscapes that aim to support population growth and urbanization sustainably.

## 7.4 Application and Results

The concept of a pattern language, as described by Alexander in "A Pattern Language: Towns, Buildings, Construction" (1977), provides a methodological framework for sustainable urban design. It consists of a series of interconnected patterns applicable to various scales, ensuring cohesive development across buildings, neighborhoods, and cities. This chapter explores sustainable approaches to managing population growth and urbanization in arid regions, focusing on Tamansourt as a case study. Effective implementation of the proposed Urban Arid Green language necessitates early engagement of all stakeholders to ensure comprehensive understanding and support (Fig. 7.12).

To transition Tamansourt into an ecocity, socio-spatial design guidelines emphasizing biosphere sustainability are crucial (Fig. 7.13). These guidelines integrate insights from Al Omrane's design principles with new patterns focused on circularity, ecology, supportive lifestyles, and urban fabric facilitation. The transformation of Tamansourt involves reorienting its urban fabric from being Marrakech-centric only to a more self-contained, community-oriented structure as well. This shift includes improving local infrastructure and creating vibrant communal spaces like seasonal parks and central hubs for agriculture, education, and tourism. Addressing infrastructural needs, such as redesigning major roads like the Marrakech-Safi highway, promotes safer, more accessible urban mobility. Enhancing these corridors as integrated hubs encourages active community engagement and economic vitality. In conclusion, the Urban Arid Green initiative aims to redefine urban development in arid areas, fostering sustainable growth and enhancing community resilience. By


**Fig. 7.12** All stakeholders speak the same language, they understand each other and work together on the transition towards an ecocity

integrating local knowledge with innovative design strategies, Tamansourt can evolve into a model ecocity, benefiting both current and future generations.

The analysis shows that Tamansourt is perceived as a dormitory city, which is lacking sufficient urban amenities and job opportunities. The urban fabric of Tamansourt supports this, it is Marrakech-oriented. For Tamansourt to lose this image, its structure must shift from being Marrakech-oriented only, to becoming Tamansourt-oriented as well. The vision for Tamansourt as designed by Al Omrane Marrakech (2008) is altered to the Tamansourt-oriented plan. Key aspects of this plan are the mobility shift, local hubs, central hub, seasonal parks, wastewater treatment, and appropriation.

The mobility shift improves accessibility (Fig. 7.12). Tamansourt is designed to be dense, therefore the urban fabric between buildings and their interaction is important to the spatial quality. As the open public space primarily comprises infrastructure, a shift in mobility is necessary. Currently, the Marrakech-Safi highway runs through the core of Tamansourt. Pedestrian bridges allow slow traffic to pass over this fast traffic. The highway splits into 14-meter-wide asphalt avenues, dividing the city and creating both physical and non-physical barriers. By prioritizing the outer road for entering or crossing Tamansourt, slow traffic within the city is given precedence and enhanced comfort. This approach reduces the infrastructure's barrier effect within the urban layout. Prioritizing slow traffic and shared mobility will foster safer, healthier, and more social mobility. As a result of this shift, the city's grand avenues can evolve from mere traffic arteries to vibrant urban axes of activity, connecting various centers. The outer road will link the rewilded natural landscape or agroforestry areas to industry, businesses, the university campus, and housing with retail. The design principle for the outer road emphasizes safety. Here, slow

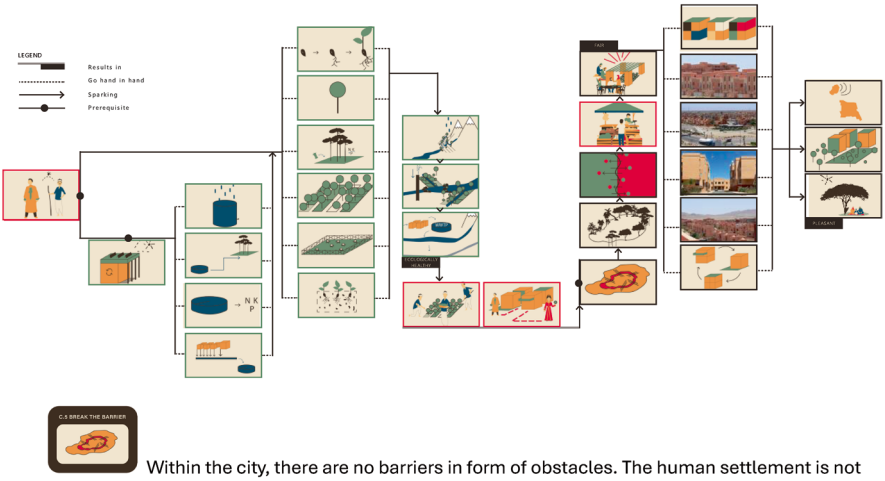
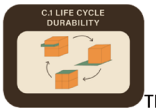



**Fig. 7.13** Urban Arid Green Pattern Language

Development must ensure an improvement of the quality of space.

Spaces for common interest around the city are available to everyone.

Safe & comfortable spaces allow people to come together in public space.



The urban form of the city allows inhabitants to grow through different stages of life.

Identity must be created. Although a city must look as one whole, the city allows individuality.

Entities are created throughout the city.

The idea of the Ecocity is lifted to the regional scale.

The urban form is super clear. It is easy and safe to explore areas one does not necessarily has to go to.

Businesses are functioning via a low-profile business operation. Over-modern methods, equipment and technology is omitted.

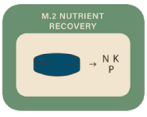
**Fig. 7.13** (continued)

The financial system is fair.

The population acquires know-how by education and training. This must be open to all, disregard one's status.

In the urban area, vegetation is included in every private plot. On the plot, this can be done in various ways via greening gardens, façades, balconies and roofs.

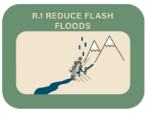
Wastewater is treated. This can be done via centralized and decentralized methods, on different scales.



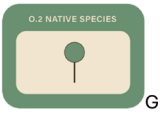
Nutrients are recovered from wastewater. This can be done via centralized and decentralized methods on different scales.

On agricultural land, perennials are mixed with annual crops.

Create healthy soil ecosystems with techniques as cover cropping, residue mulching, conservation agriculture, phase rotations and creating continues vegetation cover.



Flash floods must be reduces by infiltrating water as soon as possible. Downstream, room for the river is made to lower peaks in discharge.



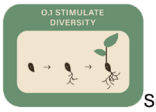
Grow native species to green the environment

**Fig. 7.13** (continued)

Livestock/wildlife is not repeatedly grazing of vegetation at such pace that the vegetation does not have the time to regrow.

Aim for closed cycles on every level, that have as little negative impact on the environment as possible.

Stop depletion of the aquifer by lowering the water intake from the aquifer on agricultural land.



Support genetic diversity amongst vegetation, to stimulate its resilience.

On green spaces, only organic fertilizer is used, made out of household waste or nutrient recovery.

Excess water is captured and stored for later purposes.

Water reuse is safe, following possible restrictions as for instance covered irrigation only.

Water is not only taken from the natural system. Clean water is also returned to nature, replenishing the aquifer.

Urban, landscape and architectural design refer to local architecture in a modern way. High maintenance is avoided.

**Fig. 7.13** (continued)

Buildings interact without seeking symmetry. There is a diversity in architecture between blocks, but unity within blocks.

The hierarchy in routes is clear and expandable. Different functions in different districts. Non-residential buildings are more expressive.

The new towns are linked to other cities. They adapt to the relief and are integrated to the geographical and historical site. Their territory allows further development.

**Fig. 7.13** (continued)

and fast traffic are separated, adequate lighting is provided, pedestrians are prioritized, and bus stops are strategically located. Since the outer road is not yet built, its layout can be reconsidered and optimized (Fig. 7.14).

By qualitative densification of the fabric, the agglomeration power strengthens. The urban area is activated with spaces for common interest in the three, by Al Omrane appointed, centers. This allows specification and diversification of functions. The central hub is located on the northeast side of Tamansourt, outside the planned outer road. Here, food production, education, research, and touristic activities synergize.

The quality of life is further improved via the greened wadis enclosing the ecocity, that translate the old Moroccan medina walls into those of a new ecocity. Creating two linear parks for all inhabitants to enjoy. To activate this new ecocity framework, spaces for social gathering are created. These are located within the seasonal parks and central hub on the activity strip, on the continuation of the main axis in the city.

The local hubs provide essential services to enhance community life. At the shop, locally grown food from the central hub is available for purchase, ensuring fresh produce for residents. Nurseries cultivate urban greenery, encouraging locals to participate in city greening efforts. Cafes and restaurants utilize local ingredients, promoting economic opportunities and fostering social interactions among residents. These centers serve as focal points for community engagement and empowerment. Addressing deficiencies identified in the analysis, each hub in Tamansourt is tailored to meet specific community needs. This customization ensures that amenities align closely with local demands and complement existing functions within the hub's vicinity. Variations between hubs reflect unique characteristics and priorities. The design of local hubs is influenced by the visionary model at the Al Omrane Tamansourt office with adjustments made to accommodate existing built structures where necessary.

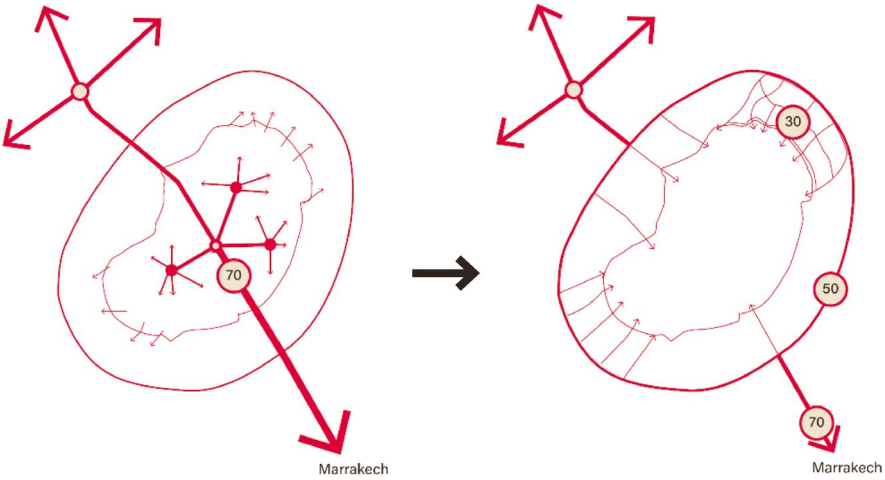



**Fig. 7.14** Rethinking the mobility of Tamansourt

The analysis highlighted existing green avenues within Tamansourt's infrastructure, crucial for maintaining pleasant boulevards. The vision for Tamansourt in 2040 involves extensive community involvement in urban greening efforts. Based on Al Omrane's zoning plan, residential areas with shared courtyards aim to maximize ground-level green spaces. Buildings without outdoor areas prioritize rooftop and vertical gardens. This diverse approach to urban greening enhances mental well-being, urban climate, and overall quality of life. The selection of plant species for Tamansourt's built environment includes native drought-resistant species alongside a variety ornamentals within the inner-city. The southern hub features public football and tennis courts, enhancing local recreational opportunities. These facilities bolster the area's sports scene and complement nearby amenities like parks and a mosque. Linked to a new residential neighborhood via the outer road, the central hub prioritizes pedestrian and public transport access. This hub serves as a gateway to the activity strip, promoting agroforestry and tourism. The hub's elevated position compared to the city, higher on the foot of the Jebilet, offers panoramic views of seasonal parks and forests. It will support educational and research activities.

The central hub pioneers perennial ecosystemic agriculture, transforming desertified areas into productive ecosystems. A diverse mix of native, drought-resistant trees and crops are cultivated, supported by a robust selection process. Governmental policies and local initiatives aim to sustain this agricultural transformation, ensuring food security and economic resilience. Tamansourt strives for a self-sustaining local food chain, promoting crop rotations and sustainable harvesting practices. Calculations must indicate the necessary land area for agroforestry to meet local dietary needs, emphasizing the community's commitment to food security and environmental stewardship. By focusing on community-based initiatives and sustainable urban planning, Tamansourt aims to achieve a harmonious balance between human development and ecological resilience.


**Fig. 7.15** Agroforest formation

### *7.4.1 Formation of Agroforestry*

The initial stages of creating the Agroforest in Tamansourt begins with tree planting and trenching to transform the barren landscape into a thriving food forest (Fig. 7.15). These trees provide shade, initiating microclimate adjustments. Subsequently, organic waste and recovered nutrients facilitate humus and soil formation, closing nutrient loops. Pruning and leaving branches further accelerate this process. Once conditions permit, crops are introduced between trees, marking the onset of agroforestry. As the forest stabilizes, harvesting of its products becomes feasible. Certain trees and crops, such as Quercus suber (Cork oak), require long-term planning, with harvests occurring after 25 years for these specific oaks, and every 9 years thereafter. Maintaining a detailed harvesting schedule ensures optimal workflow management.

The agroforestry site incorporates several design patterns, and shows the spatial result (Fig. 7.16).

### *7.4.2 Seasonal Parks*

The seasonal parks play a pivotal role in preventing urban flooding in Tamansourt. By harnessing wadis more efficiently, these parks enhance city livability. Aggressive flash floods are managed through nature-based hydraulic solutions, essential for safeguarding erosion-prone gullies. Engaging communities residing along these gullies is crucial for Tamansourt's sustainable development. By transitioning from erosion gully to park, rainwater is allowed to seep into soil, replenishing reserves rather than causing erosion. The transition demonstrates key hydraulic measures of Tamansourt's waterbody. Slowing water flow and preventing overgrazing are primary strategies in restoring water bodies. Tamansourt's seasonal parks, exclusively feature native, drought-resistant flora that can withstand the fluctuating conditions of the wadi. This strategic selection minimizes maintenance costs while highlighting Morocco's indigenous biodiversity, boosting tourism and cultural significance.

The development of seasonal parks focus initially on livestock and water management, followed by natural regreening efforts and active afforestation (Fig. 7.17). Enhanced water infiltration and vegetation cover improve water safety and


**Fig. 7.16** Impression Agroforestry Central Hub


**Fig. 7.17** Phasing Seasonal Park

maintenance efficiency, creating local employment opportunities and fostering community engagement.

The potential outcome of the park shows the integrated design patterns (Fig. 7.18).

Seasonal parks encircle Tamansourt akin to historic Moroccan medina walls. Rammed-earth canopies strategically positioned throughout provide shade and social gathering spots, blending with the arid landscape. These canopies, drawing inspiration from Marrakech's El Badi Palace offer both shade and potential for solar energy generation, contributing to a sustainable urban environment.

Tamansourt's sustainable urban development integrates ecological restoration with community-centric amenities, fostering resilience against environmental challenges while promoting cultural heritage and local economic growth.

In 2024, the primary objective is clear: Tamansourt must transition into an ecocity. Achieving this goal requires robust top-down support to initiate data collection and foster open knowledge exchange. Collaboration among stakeholders within Tamansourt and neighboring new towns is essential. Local communities are energized and mobilized through this support and participate in finalizing the urban landscape design.

Locals can initiate decentralized wastewater treatment early on, a process that will evolve and strengthen with the introduction of tourist facilities. By 2030, as Tamansourt becomes more self-sufficient, plans for a wastewater treatment plant


**Fig. 7.18** Impression of the Seasonal Park

(WWTP) can commence, followed by the reconstruction of sewage infrastructure upon completion. The WWTP's construction aligns with the finalization of sewage infrastructure to ensure effective water recovery. Simultaneously, nurseries and storage facilities can begin construction, and grazing control barriers established. These preparations facilitate seedling growth and kickstart active regreening efforts during rainy seasons, initiating the local food chain production. Once wadis and agroforestry sites are sufficiently regreened, the development of tourist facilities completes the activity strip. This phase introduces agro- and ecotourism to the area, prompting the formulation of a tourist program and generating new employment opportunities. Given the extended timeline for infrastructure design and reconstruction, phased implementation by district or project can start concurrently with the design phase. Local hubs can be constructed alongside infrastructure reconstruction. Educational and research centers can be established following the completion of the central hub's design. These centers, like a Faculty of Nature, Environment, and Agroforestry, utilize ongoing data collection efforts. Each phase's prerequisites ensure progression, allowing subsequent phases to commence upon achieving specific goals.

The project's adaptive pathway approach incorporates different sustainable scenarios toward achieving the ultimate goal. This flexible approach acknowledges uncertainties such as climate change impacts, socio-economic challenges, and external factors. It avoids linear processes and ensures continuous reflection and adaptation. Shared understanding and awareness among stakeholders are fostered. Workshops are pivotal in creating a socially safe environment for discussing actions and committing to common goals, despite any potential setbacks.

## 7.5 Discussion and Conclusion

Tamansourt's journey toward becoming an ecocity by 2040 underscores Morocco's strategic response to urbanization and population growth through new town expansion. The Urban Arid Green project exemplifies how urban landscapes can restore natural systems, integrating a green framework to foster sustainable interactions between humans and the environment.

Key to this transformation are systemic changes encompassing environmental, policy, and behavioral dimensions, addressing soil degradation and environmental challenges exacerbated by climate change. The project empowers local communities through collaborative efforts and bottom-up initiatives, ensuring the co-creation of a regenerative urban landscape.

The Urban Arid Green pattern language guides development by spatializing theoretical guidelines and aligning with the UN's Sustainable Development Goals, prioritizing sustainability at its core. As Tamansourt transitions into an ecocity, lessons from this project are applicable to similar landscapes, promoting communication and inspiring global sustainability efforts.

In managing scarce resources like water, food, and energy, urban design plays a pivotal role in creating circular systems that optimize resource use while fostering equitable social and economic structures. Local engagement is central to the ecocity's success, ensuring sustainable urban development that adapts to future uncertainties.

Ultimately, Tamansourt's journey represents a model for sustainable urban development in arid regions, emphasizing adaptability, resilience, and community-driven initiatives in shaping a sustainable future.

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