

Hariyo Mala

Integrating
agriculture
as essential
infrastructure
in Kathmandu

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Approval

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Abstract

As a result of decades of rapid unplanned growth, urbanization in the Kathmandu Valley has been unsustainable and haphazard. Today, Kathmandu's food systems in particular are increasingly subject to the effects of a diminishing foodshed and loss of its historical agricultural identity, compounded by stressors such as natural disasters and climate change.

Urban agriculture could be a linchpin, not only supplementing local food requirements, but providing key ecosystem services, supporting social and infrastructural resilience, and fostering self-determination for communities historically marginalized by the state. However, for urban agriculture to achieve this potential, it needs to be embedded into the spatial, cultural, and ecological systems of the built environment. Through Research by Designing, this project explores this question and asks how this integration of urban agriculture could be achieved. To answer this, the project focuses on the concepts of urban agriculture, green infrastructure, and agroecology. Thinking of urban agriculture as green infrastructure provides a framework for incorporating food production as one of the multiple benefits we derive from the land. Thinking of urban agriculture as urban agroecology provides a framework for incorporating practices rooted in landscape ecology and food sovereignty. Together these three concepts intersect to form productive green infrastructure. This productive green infrastructure takes the form of a system that this project proposes as the Hariyo Mala, a projective vision for future Kathmandu Valley. Nested within this are additional design proposals at the city, neighborhood and site scales that further explore strategies and elements of the Hariyo Mala system. Together, they project an alternative vision for Kathmandu, one where urban agriculture is integrated as essential infrastructure in creating a more resilient urban future for the valley.

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Background

- Introduction
- Significance
- Research Question
- Methodology



Introduction

Over the last few decades, Kathmandu has gone through considerable social, political, and environmental transformations. As the historic hub for Nepal's urban development, the valley, since the 1970's, has seen one of the fastest urban growth rates in the world (Manandhar, Parajuli, 2015) and continues to grow rapidly until this day. As a consequence of unplanned urbanization, loss of green open spaces, unprecedented pollution of waterways, and failing infrastructure are daily realities for the people of the valley. Kathmandu's food systems in particular are increasingly subject to the effects of a diminishing foodshed and loss of its historical agricultural identity, compounded by stressors such as natural disasters and climate change. Although the state government has proposed various projects to guide development going forward, inadequacies in existing policies and codes raise concerns about their implementation and effectiveness. Furthermore, there is an absence of ecological planning, bottom up stakeholder participation, and consideration of indigenous minority rights and identity. This is crucial, particularly today, when construction of highways, airports, and dams have become central to the national dialogue as the path forward to a "New Nepal". With little regard to landscapes and the communities that inhabit them, these infrastructure works are poised to have massive consequences for urbanizing cities such as Kathmandu, and their surrounding environment throughout the country.

Here, urban agriculture could be a linchpin, supplementing local food requirements, providing key ecosystem services, supporting social and infrastructural resilience, and fostering self-determination for marginalized and indigenous communities. There is a potential for Landscape Architecture to augment the benefits that urban agricultural practices provide, mitigate the negative environmental and social impacts, and integrate urban agriculture into the larger fabric of the city and its surrounding landscape. To do this requires landscape architectural thinking, in terms of arrangements of stakeholders and actors (Abelman, 2014), in terms of ecological and cultural systems (Philips, 2013), and in terms of food and infrastructure systems, to comprehend and shape the complex relationships that food and landscape share with each other (Potteiger, 2013). Thinking of urban agriculture as green infrastructure provides a framework for incorporating food production as one of multiple benefits we derive from the land, and managing the many conflicting pressures put on productive landscapes. Thinking of urban agriculture as urban agroecology creates opportunities to incorporate principles of ecology and the values of food sovereignty, into the urban food system.



Peri-urban agriculture in the outskirts of the valley
Bhairab Raj Kaini



Rooftop gardens within the city limits
City farmer news



Vegetable gardens in vacant spaces within the city
Sattya Media Arts Collective

Significance

This research will contribute new knowledge to the field of landscape architecture by developing strategies for integrating urban agriculture as an essential infrastructure for a sustainable and resilient city. It draws from the concepts of green infrastructure, urban agriculture, and agroecology to draw new strategies to achieve this integration.

Drawing from the concepts of green infrastructure, the research explores how urban agriculture can be connected to open, green spaces and natural systems in the city. Drawing from the concept of agroecology, it explores how urban agriculture can be redesigned with principles of ecology and food sovereignty. Synthesizing key principles from these concepts, the research explores strategies applicable to landscape design. Taking the Kathmandu valley as its area of study, the research tests these strategies at different spatial scales, from the city-region scale to the scale of a site.

Employing research by designing as its main method of inquiry, the project aims to develop generalizable knowledge that can help inform landscape architects and design practitioners in the design of resilient productive landscapes. Specifically in the context of Kathmandu, the research proposal could inform urban planning and landscape design in Kathmandu and other growing cities in the country. The research could contribute to the current development discourse taking place in Kathmandu and in the country, and help promote the value of sustainable and integrated urban agriculture in addressing complex transformations taking place in the country.

Research Question

The research project is lead by the following overarching question:

How can agriculture be integrated into the fabric of Kathmandu as essential infrastructure to create a more sustainable and resilient urban future for the valley?

Document Structure

The research is organized into 6 chapters. Following chapter 1 where the background of the project is introduced, chapter 2 describes the focus of the research and provides explanation of the key concepts from literature. In chapter 3, key principles and strategies are synthesized from the key concepts, and new strategies are derived. Elements, typologies, and practices are combined to form a kit of parts. Chapter 4 comprises of a description of the study area of Kathmandu, Nepal, while, Chapter 6 consists of projective design explorations of strategies derived. Finally, Chapter 6 concludes the research project with a discussion of findings and reflections of the design exploration.

Methodology

Research through designing (RTD) is the main methodological approach used in the project, where designing activity is employed in the research process to generate new knowledge; knowledge which more specifically, according to Deming and Swaffield (2012) is, “produced inductively through design setting and deductively through the testing and challenging of established concepts and claims”.

Research by Design

Pragmatic Knowledge Claim

Designing activity is employed in the research process to generate new knowledge

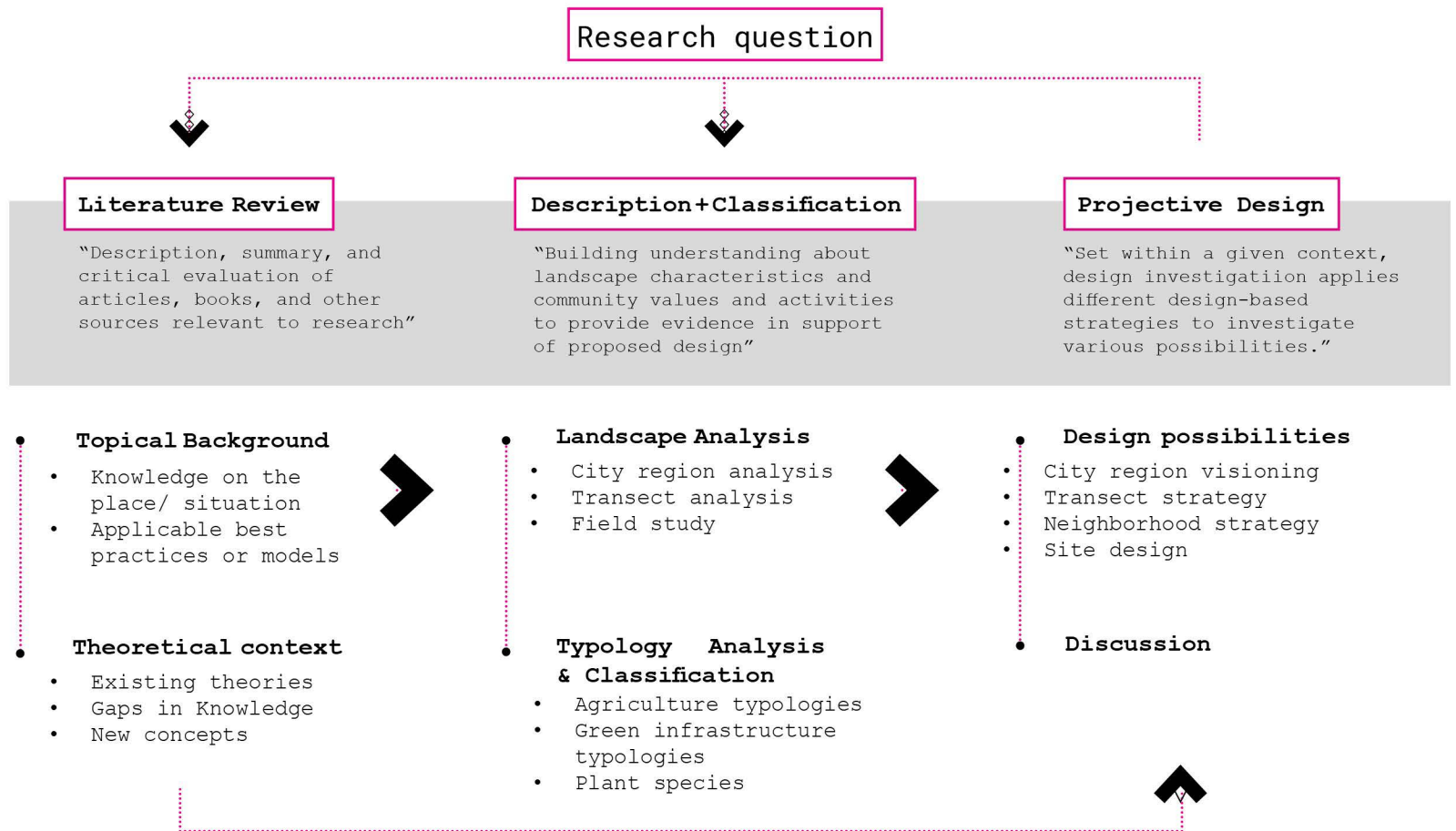


Diagram of research process

Literature review

The research involved description, summary and critical evaluation of articles, books, and other sources relevant to the topics of urban agriculture, green infrastructure, and agroecology. The research conducted a general study of literature on the three topics, seeking to gather fundamental understanding of key principles, benefits and importance, typologies, and methods of application in design and planning. The literature review also involved a study of agriculture in the Kathmandu valley, its relation to the process of urbanization, and the present context of food production.

A study of the infrastructure projects proposed by the state was conducted to develop understanding of the infrastructure and urban development goals for the valley, and its relation to food production. This method was used to build the foundational context for the project. It helped develop an understanding of the three key topics, clarify the interconnections between them, and set up opportunities for synthesizing new design strategies. The literature review also helped describe the historical and present context of agriculture and food production in Kathmandu and define possible areas of intervention in relation to the goals put forward by the state.

Description + classification

Focusing on Kathmandu, descriptive and classification strategies were used to build understanding of the landscape characteristics of the valley. Through field observation, and mapping, analysis was conducted first at the city region scale to develop understanding of the land available for agriculture, open spaces, forest land, and river systems. This information was cross examined with infrastructure proposals developed by the government to spatialize possible areas of urban agricultural intervention. This classification helped in the selection of a landscape transect along which further design interventions would later be explored. The research also studied the cultural values and practices necessary to support urban agriculture in the valley, and accordingly, its

integration as green infrastructure in the ongoing process of urbanization. Typological analysis and classification study was conducted to create a list of components consisting of green infrastructure asset types, urban agriculture typologies, and agroecological practices. Similarly, a matrix of native edible tree and plant species were compiled which helped to develop a design palette. These methods thus were used to conduct a spatial analysis of the study area, select a transect for further design investigation, and build a list of components to supplement the projective design section of the research.

Projective Design

Through design explorations at different scales, the research investigated how agriculture could be integrated into the fabric of Kathmandu as essential green infrastructure. Applying design strategies generated in the research process, projective design solutions were explored on different scales: A conceptual vision at the city-region scale; an urban scale productive green infrastructure strategy explored along a transect; a neighborhood scale concept; and finally design at the site level. The design applications were then reviewed to draw generalizable conclusions and the findings were described in the discussions chapter.

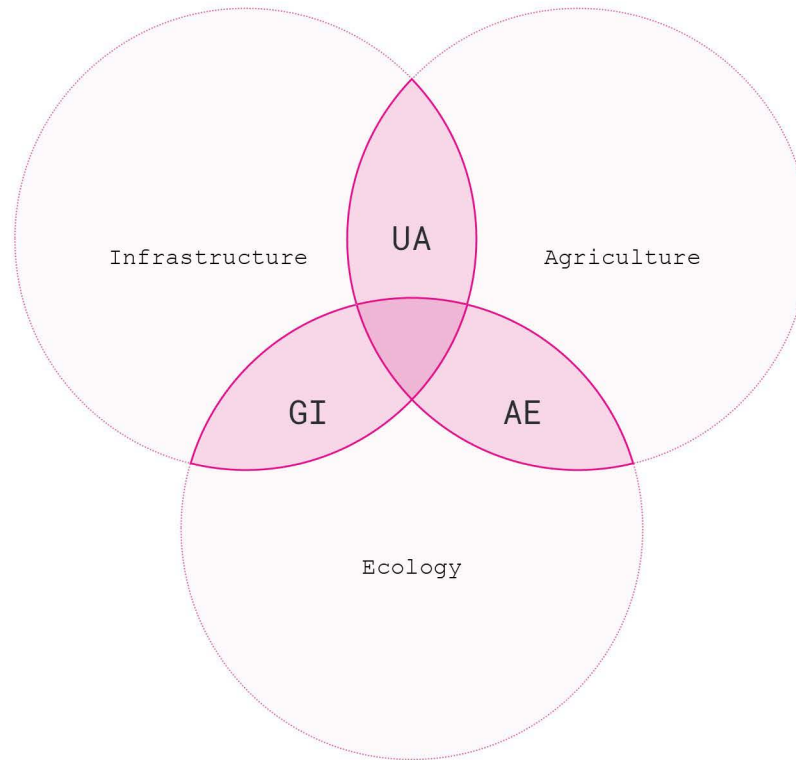
The design process produced design explorations at various scales of intervention. The deliverables of the process were then reviewed to draw take-aways and highlight areas for future research. This project through research by designing created generalizable knowledge that could inform landscape architects and allied professionals working on issues of green infrastructure and urban agriculture, thus meeting Deming and Swaffield's criteria for design to become an autonomous research strategy by "producing new generalizable knowledge about the world through its purposes, protocols, and outcomes" (Deming et al., 2012)

Key Concepts

- Project Focus
- Urban Agriculture
- Green Infrastructure
- Agroecology

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Project Focus



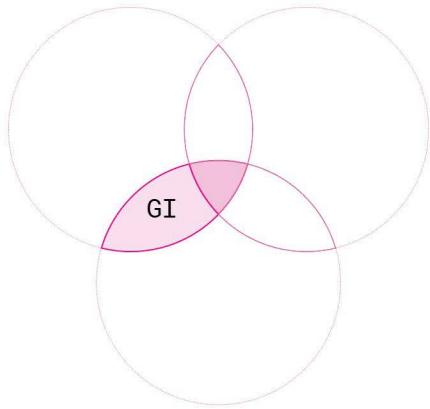
GI Green Infrastructure
UA Urban Agriculture
AE Agroecology

Diagram of intersection of key concepts

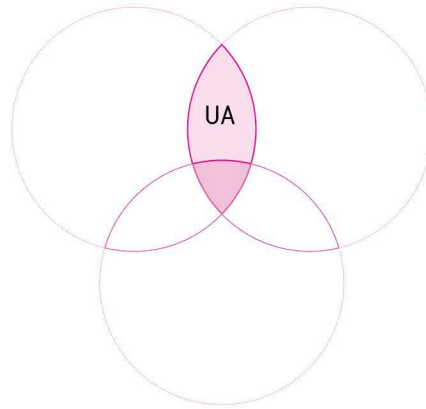
The research focuses on the intersection of the topics of green infrastructure, urban agriculture, and agroecology to answer the research question - integrating agriculture in the Kathmandu valley to envision a more sustainable and resilient urban future.

Urban agriculture provides a multitude of benefits, from access to fresh and healthy food, to social integration, to employment opportunities and encompasses a wide range of productive typologies (Lin et al., 2017). Thinking of urban agriculture as green infrastructure creates opportunity for incorporating food production as one of multiple benefits we derive from the land, and creates an opportunity for urban agriculture to gain spatial significance in the city where green infrastructure assets are combined with food productive functions to create new hybrid typologies (Viljoen et al., 2019).

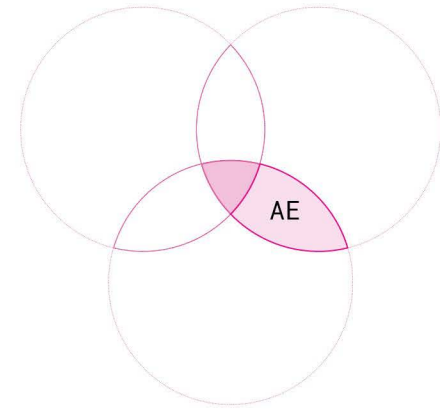
Implementing the principles and practices of agroecology in urban agriculture creates opportunities to incorporate principles of ecology and the values of food sovereignty, into the urban food system (Tornaghi et al, 2020).



Green Infrastructure (GI) spatially and functionally integrated systems and networks of protected landscapes supported with protected, artificial and hybrid infrastructures of built landscapes that provide multiple, complementary ecosystem and landscape functions to the public, in support of sustainability (Ahern et al., 2014).



Urban Agriculture (UA) cultivation of food, and the raising of animals in and around cities (Tornaghi, 2014; Hou, 2017).



Agroecology (AE) an integrated approach that applies ecological and social principles to the design and management of food and agricultural systems (FAO, 2018).

Guided by the research question, this research first extracts key principles from Green Infrastructure and Agroecology. Taking these key principles, the research then draws strategies that can be applied to integrate urban agriculture into the urban landscape. A matrix is also synthesized from literature and lists key urban agricultural typologies, green infrastructure assets, and agroecological practices. The matrix acts as a tool to support the strategies and further guide the design research.

Urban Agriculture

- Provides multiple benefits in addition to food
- Comes in various forms and scales
- Has potential to contribute to socio-ecological resilience of city
- Needs systems thinking to be integrated into larger city

Urban agriculture (UA) maybe defined as the cultivation of food, and the raising of animals in and around cities (Tornaghi, 2014; Hou, 2017).

It encompasses a wide range of spaces and practices manifesting in various forms and sizes from small kitchen gardens, to large agricultural estates (Philips, 2013), and even include practices considered as subversive and interstitial such as foraging and guerilla gardening (Galt et al, 2014).

Historically a vital part of urban life, urban agriculture has been experiencing a recent resurgence around the world (Tornaghi, 2014; Hou, 2017).



Farmers Busy on Field near Taudaha, Kathmandu
Saroj Pandey

Previously pushed out of city boundaries by exclusionary regulations, or limited to residual spaces over the past decades, today, urban agriculture projects find their place back in urban life, influencing the urban form, challenging land-use policies and creating dialogue on novel ways of using public space (Galt et al, 2014). The proliferation of urban food production presents opportunities as well as challenges for the cities of tomorrow, attracting interest and support from governments and grassroots movements, as well as from a range of diverse professions, including landscape architecture (Hou, 2017). As cities continue to grow and densify, urban agriculture is uniquely able to also help alleviate poverty and food insecurity, which is particularly the case for many underdeveloped countries around the world.

Background

There is a fundamental relationship between food production and how cities have formed and developed. The earliest permanent human dwellings were places that supported a communal economy based on food production and storage (Steel, 2012). Historical indications of urban agriculture, going back as far as 10,000 years ago, illustrate that various civilizations used to farm in contained and controlled zones within the city compounds as part of their daily rituals (Philips, 2013).

In the semi-desert towns of Persia, some 4,000 years ago, intensive food production was supported by water transported through aqueducts and nurtured by wastes from the nearby communities. In Machu Pichu, scarce water was reused over mountain terraces for biointensive vegetable beds designed to catch the afternoon sun and stretch the season, all in proximity to the built environment (Viljoen, 2005). In more recent history, during World War I and II, war gardens and victory gardens were created en masse in private residences, schools, and vacant lots, to reduce pressures on the public

food supply and to cultivate produce (Philips, 2013). Over the past decades, planners and governments have opted to ignore and or actively discourage food production within the city (Galt et al, 2014). Tornaghi (2014) lists combinations of three factors: land privatization from pre-feudal times to modern days, colonial impacts on agricultural markets and food commodification, and application of modernist planning on public spaces, as a primary agents of creating the contemporary urban form and the "residual space of urban agriculture".

Daniel Winterbottom defines this residual space as having detached qualities, being left over, or having little opportunity for meaningful engagement by the community (Winterbottom, 2000). Modern capitalist agriculture and transportation systems have also further increased this separation between food production and food consumption (Philips, 2013), with neoliberal trade policies promoting and normalizing the marginalization of urban food production (Galt et al, 2014).

Modern agricultural systems are characterized as consistent of the subjugation of socio-ecological processes to create food based on capital's laws of motion. Capitalist production is seen as alienating the producer from the object, as well as from the bio/physical environment the object is produced from. A consequence of this rationality, Galt et al. write, is the unprecedented concentration of market power - At present, 30 companies handle 30 per cent of global food trade. Embedded in this dominant system are unjust labor practices, loss in genetic diversity, and vulnerability to health hazards (Steel, 2012; Tornaghi, 2014).

In opposition, today, various social movements such as organic food, slow food and local food, and various peasant movements have started to advocate strategies for respatializing food systems, including shortening food miles (Feagan,2007 in Potteiger, 2017). These movements frame the public discourse around the relationship between food

and place, and also provide opportunities for landscape interventions (Potteiger, 2017). Here, the urban and vacant plot gardens in Detroit, the Garden City initiative in Taipei, and the Organiponicos in Cuba illustrate key examples of urban agriculture practices taking place and gaining recognition around the world. They highlight changing attitudes against dominant agriculture systems and showcase a strong rising concern for environmental and for social justice (Tornaghi, 2014).

Typologies

Urban agriculture comes in a variety of forms, from a small planter bed to a large edible forest. They can range from being a for-profit operation to being public run with varying physical characteristics and programmatic features. The following list highlights some of the common typologies of urban agriculture (Cohen et al.,2012) (Lin et al., 2017):

Private gardens

- Rooftop gardens
- Edible estates

Urban orchards

Edible forests

Community gardens

- Victory gardens
- Yard share

Community farms

- Multifamily landscapes
- Rooftop farms

Easement gardens

Commercial farms

Institutional farms

- Edible hotel/resort landscapes
- Restaurant farm to table
- Learning and demonstration gardens
- Research / experimental farms
- Food pantry gardens
- Edible school gardens

Benefits

In addition to providing food for consumption, Urban agriculture provides a multitude of environmental, social and economic benefits

(Viljoen, 2005) contributing to the livability, sustainability, and resilience of cities (Lin et al., 2017). To farmers and gardeners, growing food is important, but often it is a means to other goals as well.

Urban agriculture can provide access to healthy and affordable food, create safe spaces, stimulate job growth and aid in promoting environmental stewardship (Cohen et al, 2012). These practices and spaces help transform people, as well as their social and ecological relationships at various levels and scales (Galt et al, 2014).

A partial list categorizes and enumerates these benefits as follows: (Philips, 2013) (Hou, 2017) (Lin et al., 2017) (Palmer et al., 2016):

Health

- Better access to fresh and affordable produce
- Improved dietary nutrition and diversity
- Leisure, recreation, and physical activities
- Food-health literacy

Ecological

- Variation in vegetative complexity and diversity
- Arthropod diversity including pollinator species
- Ecosystem services such as stormwater management, carbon storage and sequestration

Social

- Food security in times of crisis
- Access to culturally relevant food and medicinal plants
- Community building through social interaction and cross-cultural learning

Economic

- Local food production and economic stimulation
- Job growth and readiness
- Food affordability and household savings

Multimodality and Resilience

Jeff Hou (Greening cities, 2017) echoing these benefits talks of how places of urban agriculture, specifically, urban community gardens, perform multiple functions. Urban community gardens, he writes, act as convivial space, cultural space, inclusive space, restorative space, democratic space, and resilient space. Through multiple functions and multiple modes, community gardens act as critical social infrastructure augmenting the urban and social fabric - as places where people develop individual agency as well as social ties with other community members, and where cross-cultural learning and building of connections is encouraged.

In particular, as resilient space, Hou writes, urban gardens provide a social safety net to communities in the event of a disaster. The gardens help build social ties and through food production, provide resilience in times of crisis, whether a sudden natural disaster, or a slower economic downturn (Kranzy, 2007 as used in Hou, 2017).

Here, not only was the physical space important for resiliency, but so were the social ties developed in creation of the physical space. Williams (2014) writes of how urban gardening as a collective enables low income communities to create a better opportunity for themselves and become resilient. A more resilient community in terms of disaster preparedness and climate change, in turn becomes more progressive and productive (Golez, 2013, as cited in Hou, 2017). Here, the term 'resilience' is derived from 'socio-ecological resilience', that is, the notion of apparent alternative stable states and is concerned with persistence, change, and unpredictability (Gunderson et al, 2002, as cited in Hou, 2017). Critical factors to developing resiliency include: (1) learning to live with change, (2) nurturing diversity, (3) combining different knowledge types for learning, and (4) creating opportunity for self-organization and cross-scale linkages. Community gardening,

and urban agriculture in general, can speak to this idea of socio-ecological resilience, as they provide opportunities for social learning and lifestyle adaptations, speak to specific community and environmental concerns, and encourage cross scale linkages (Folke 2003, as cited in Hou, 2017).

Integration into the Urban Fabric

Urban Agriculture(UA) provides many benefits, including local food production, community engagement, and recreation (Lin et al., 2017). At the same time UA practices face many obstacles for larger scale implementation and integration into the urban landscape. Here, much of the debate is centered around development pressures, and environmental and health concerns (Lin et al., 2017). As urbanization increases, productive lands face pressures from other competing types of urban development (Lin et al., 2017)(Cohen, 2012) in addition to facing opposition from exclusionary zoning systems currently instated in most places. At the same time, due to use of pesticides, and food production in contaminated sites, UA may end up resulting in human and environmental health problems through metal uptake in crops from contaminated soils. There is also the possibility of spillover from farms to natural systems, of weed, pathogen or pest populations, potentially harming native ecosystems. Furthermore, new UA and green spaces can also result in increased housing and property values exacerbating/contributing to gentrification by forcing residents to find affordable housing elsewhere (Lin et al., 2017).

There is a potential for Landscape Architecture to augment the benefits that urban agricultural practices provide, mitigate the negative environmental and social impacts, and integrate UA into the larger fabric of the city and its surrounding landscape. Systems thinking becomes crucial in achieving this integration towards a more sustainable food system that focuses on health, community, and ecosystems (Philips,

2013). *Re-imagining urban agriculture, from scattered small scale projects, to larger cohesive productive landscapes at the sacle of the city* - requires landscape architectural thinking, in terms of arrangements of stakeholders and actors (Abelman, 2014), in terms of interlocking ecological and cultural systems (Philips, 2013), and in terms of food systems, to comprehend and shape the complex relationships that food and landscape share with each other (Potteiger, 2013). This need highlights a gap in current knowledge i.e. for research, planning, and design led inquiry, and to coherently embed urban agriculture into the build environment through the consideration of space. Conversely, supporting the integration of urban agriculture and productive landscapes from niche activism into the urban food system, also "lead to agricultural practices gaining spatial significance within the city fabric" (Viljoen et al., 2019).

Green Infrastructure (GI) planning could be one systematic approach that considers the aspect of space, and that pushes forward the notion that UA is an important component of a sustainable city and advocates for it to be integral part of planning and design. GI planning could help add to GI's multifunctionality providing food production and associated benefits as additional functions of a GI system while helping urban agriculture and productive urban landscapes gain spatial significance within the urban fabric. Similarly, incorporating principles of agroecology could enhance urban biodiversity and ecosystem services through the design of complex and diverse agroecosystems. As a social movement, incorporating principles of agroecology could advocate for the right of citizens to land, resources, and to decide their own food and farming policies and demands social transformation to achieve food sovereignty.

Agroecology

- Is a science, approach, and movement
- Rooted in non-hierarchical and inclusive models
- Prioritizes the selective design of diversified compositions
- Supports environmental and socio-economic resilience
- Advocates for food sovereignty
- Supports closed loop community food networks
- Has potential to make urban agriculture and urban food systems more equitable and sustainable

Agroecology may be defined as an integrated approach that applies ecological and social principles to the design and management of food and agricultural systems (FAO, 2018).

Industrialized and globalized agriculture systems have been successful in producing large volumes of food and meeting the demands of the global market. At the same time, they have had negative impacts to public health, the environment, and to the livelihoods of rural, local and



A Community Forest in Nepal anchors hillsides, supports biodiversity, and provides a source of income.

WWF

indigenous communities (Altieri et al., 2000) (FAO, 2018) (NYCA - Foodshed). Characterized by centralized corporate control, extensive monocultures, and high external input dependence, contemporary systems have led to deforestation, water scarcities, loss of biodiversity, soil depletion, and have contributed to climate change. Furthermore, despite increases in food production, hunger and extreme poverty persist as critical global challenges (FAO, 2018) (Sampath, 2014).

There is a need to develop more sustainable practices in how we grow food, manage our land, and reconnect people with nature and with their historic, cultural and natural sources of food and sustenance (Altieri et al., 2000). Agroecology offers an alternative in meeting the anticipated significant increases in our food needs without depleting the environment and dis-empowering communities (FAO, 2018) (Sampath, 2014).

Principles

Agroecology utilizes socio-ecological principles to study, design and manage agroecosystems - natural ecosystems modified for the production of food, fiber, fuel and other products for human consumption and processing (Altieri, 2014). These systems are based on the application of ecological principles around the main goal of preserving biodiversity and increasing biological efficiency while maintaining self-sustaining capacity.

Diversity

An important principle of agroecology is the optimization and use of biodiversity in Agroecology (Sampath, 2014). Agroecosystems are "highly diverse and optimize richness of species and genetic resources to provide a variety of spatial and temporal plant-animal assemblages" (Altieri, 2014).

Diversity in designing agroecosystems is important as (Altieri 1994, Gliessman 1998, as cited in Altieri et al., 2000):

It increases opportunities for coexistence and beneficial synergies that enhance agroecosystem sustainability

Agroecosystems build synergies through selective design of diversified compositions and synchronization of productive activities across time and space. Building synergies enhances ecosystem functions and services such as soil and water restoration and conservation, and improved natural pest regulation mechanisms (Altieri et al., 1998 as cited in Altieri et al., 2000).

It allows for better resource use efficiency through complementarity in crop species needs, overlap of species niches, and partitioning of resources

Through the efficient use of natural resources in agroecosystems losses are minimized. Producers rely on fewer external resources, thus reducing costs and negative impacts on the environment. For example: crop rotation with nitrate catch crops such as pulses could result in substantial savings in nitrogen fertilizers by preventing loss through leaching (FAO,2016 as used in FAO, 2018)

Diversity in the soil performs a variety of ecological services such as nutrient recycling and detoxification of noxious chemicals and regulation of plant growth

Recycling of biomass becomes important to optimize nutrient availability, reduce waste and pollution, and lower economic costs. For example, in rice-fish systems, aquatic animals help to fertilize the rice crop and reduce pests, reducing the need for external fertilizer or pesticide inputs (FAO ,2018)

It can contribute to conservation of biodiversity in surrounding ecosystems

Diverse crop systems create a variety of microclimates that can be occupied by a range of

beneficial predators, parasites, and pollinators (Altieri et al., 2000)

Resilience

The level of existing diversity can also make the difference whether a system is resilient or unable to recover from stress. Agroecological practices that optimize diversity have greater capacity to recover from disturbances such as extreme weather events and natural disasters. Crop diversity also enhances resilience to climatic variability and favors arthropods and microorganisms involved in improved nutrient cycling, soil fertility, and pest regulation (Altieri and Nicholls, 2004 as used in Altieri et al., 2000). On a landscape scale, diversified agricultural landscapes resist pest and disease attack and are better able to contribute to pest and disease control functions.

Agroecology can also be crucial in enhancing socio-economic resilience. Through diversification, producers reduce their vulnerability to failure of a single crop or livestock species. By reducing dependence on external inputs, producers are less dependent on and thus vulnerable to economic risk tied to the market (FAO,2018). This enhanced resilience of people and communities through sustainable stewardship of the land and ecosystems then leads to creating more sustainable food and agricultural systems (FAO,2018).

Food Sovereignty

Agroecology recognizes that issues of food and agriculture are both ecological and agronomic. They are inherently socio-technical and that they are co-constitutions "of water, people (including their forms of knowledge, their labour), investment flows, soil organisms, and more." For peasant organisations such as the La Via Campesina, agroecology is a social movement that protects their food sovereignty - "people's right to control the conditions of the knowledge, resources and ways in which food is prepared eaten and metabolised by humans, without undermining the ecosystem or ending in self-sufficiency discourses." (C.M. Deh-Tor, 2017).

Urban agroecology practices for food sovereignty are based on (Pimbert, 2017):

- Re-embedding agriculture in nature, relying on functional biodiversity and internal resources for production of food, fibre and other benefits.
- Reducing dependence on commodity markets
- Diversifying outputs and market outlets, often with the help of citizens
- Rediscovering forgotten resources such as organic manure, and the decentralized and distributed production of renewable energy

Above all, agroecology demands for "citizens to exercise their fundamental human right to decide their own food and farming policies" (Pimbert, 2017). One way in which this demand for more democratic governance of the food system could be through cocreation and sharing of context-specific knowledge where through cocreation process, contemporary practices derived from the ecological, social, and agronomic sciences with indigenous and traditional knowledge (Altieri, 2014) (FAO, 2018).

Circular and solidarity networks

Conventional urban agriculture shares similarities with industrial food production - dependence on external inputs, linear, globalized infrastructure chains, etc. An alternative to such an unsustainable and consolidated system that assumes both an endless supply of resources as well as an endless capacity for waste disposal, would be to transition to one that is based on circular metabolism and embraces values of solidarity among different actors (Pimbert, 2017).

This alternative is based on the ecological principles of nested and intersecting resource cycles where waste is converted into something of use from. Agroecology offers such a circular system. At the scale of the city, specialized and centralized supply chains are replaced with "resilient and decentralized webs of food and energy systems integrated with sustainable water and waste management systems". These systems can be applied at multiple scales from that of "a

farm to the entire cities" by using diversification strategies, ecological clustering of industries, recycling, and re-localised production and consumption within a territorial based approach to sustainable living. Such processes would serve to both heal alienation and close waste-energy-water-food loops (Pimbert, 2017). This approach also seeks to reconnect produce and consumer. By prioritizing local markets and supporting local economic developments, alternative solidarities are created and virtuous cycles are established - strengthened and shortened food circuits mean reduced waste and inefficiencies in the system, and an increased incomes for food producers while maintaining a fair price for consumers (FAO, 2018).

Empowering infrastructure

Looking at the urban context, there is a need for collective investment in infrastructure that integrates ecological and food production into place making beyond the level of the farm. There is a need for infrastructures and permanent improvements that support farmers "as stewards of the soil and the society that depends on it". Such an empowering infrastructure would support farmers in building resourcefulness and overcoming the current lack thereof, imagining "a well-equipped urban landscape that serves agroecological food growing in its full bio-cultural diversity", where, "community-based and managed food producing hubs are rooted within an pervasive and broadly socialized urban infrastructure."

It would value decentralization and democratization of resources and seek to close the gap between the rural and urban; and reconnect producers with consumers (Tornaghi et al., 2020); contributing to a more transformative change of our food system (Tornaghi et al., 2020) (Gliessman, 2016).

Examples of such empowering infrastructures include: community owned and operated energy infrastructure, systems for collecting, storing, transferring and recycling nutrients; programmed

and spaces for seed exchanges, and seed banks; infrastructure for ready access to food processing, preservation, and distribution, including a free access to markets (Tornaghi et al., 2020).

Practices:

The following is a brief list of agroecological practices:

- Agroforestry systems
- Closed nutrient loops
- Land trusts
- Cover cropping
- Crop rotations
- Crop - livestock systems
- Diversified landscapes
- Green manures
- Horizontal formal and informal education
- Promotion of participatory processes
- Provision of public goods
- Community and farmer to farmer food networks,
- Increase access to land, biodiversity, knowledge, and technology

Agroecology in Urban Agriculture

As populations continue to live in cities around the world, urban agriculture is becoming an important alternative contributing to food security. It has been estimated that UA can provide around 15-20% of all food production. However, the question still remains - how much can cities truly be self-sufficient?(Altieri et al., 2018). Competing development interests, lack of resources such as available land, soil and compost, water and fertilizer continue to create obstacles for UA practices. Various urban agriculture movements have provided recognition for different agricultural histories and practices in the urban context extending the possibility of connecting the urban with nature (Almeida et al., 2017). However, not all urban agriculture practices employ equitable, sustainable and ecological principles.

(Altieri et al., 2018) illustrate through examples from urban farms and gardens from different parts of the world that "self-sufficiency in terms of vegetables could potentially be achieved at the level of a community or city if such UA farms were re-designed and managed using agroecological principles and that well-designed urban farms could be up to 15 times more productive in terms of total output than rural holdings". Altieri et al. (2019) write that the same Agroecology principles, traditionally applied in small holder farms in rural contexts, can be applied to urban agriculture practices for recycling of nutrients and organic matter turnover for soil fertility, closed energy flows, water and soil conservation and enhanced pest regulation all key processes necessary to maintain UA productivity and enhance the ecosystem (Altieri, 1995).

Moving beyond farm management - rethinking of urban agriculture as urban agroecology could provide an avenue to "collectively think and act upon food system knowledge, access to healthy and culturally appropriate food, decent living conditions for food producers, and the cultivation of living soils and biodiversity" (Dyck et. al, 2017). Agroecological thinking could be a way to move 'agricultures' in the city away from purely market oriented logics of production, and towards "connecting social function with the value of land configuring new metropolitan territories, and reinvigorating livelihoods based on socio-environmental reproduction".(Almeida et. al., 2017).

Michael Pimbert(2017) summarizes that urban agroecology could transform food production in the city on three dimensions:

1. Ecological: Reorganizing the material basis of food production in the image of nature
2. Political: Expanding citizen participation and democracy in the co-production of knowledge , policies, and urban space
3. Economic: Inventing forms of economic organization around re-territorilizing food and wealth production

Green Infrastructure

- Interconnected system
- Connection is essential to improve overall system function
- Values natural systems as essential to sustainability
- Prioritizes multiple functionality and the maximization of ecosystem services
- Borrows spatial concepts from landscape ecology
- Is multiscalar

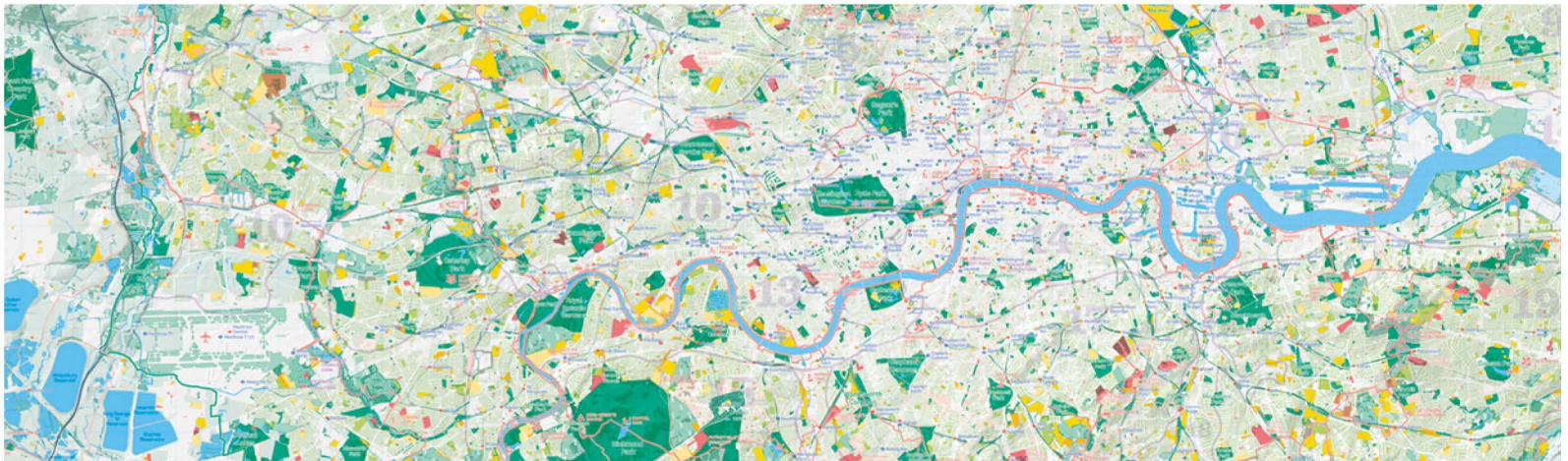
Green Infrastructure (GI) maybe defined as "spatially and functionally integrated systems and networks of protected landscapes supported with protected, artificial and hybrid infrastructures of built landscapes that provide multiple, complementary ecosystem and landscape functions to the public, in support of sustainability" (Ahern, 2014).

First coined in Florida in 1994, GI as a concept combines 'green' and 'infrastructure' to advocate for the importance of natural systems as infrastructure and to push forward

the notion that they be considered a key part of planning processes (Firehock, 2015). Natural areas and features, working landscapes, and open spaces provide multiple functions and deliver a range of benefits including but not limited to habitat conservation, stormwater management, and ecological resilience (TLI, 2009). GI planning is based on the understanding that these resources are interdependent, and that through connectivity and integration, they allow for synergistic benefits through multifunctionality including ecological resilience (Firehock, 2015) (TLI, 2009).

Principles

When appropriately planned, designed and managed as a continuous network, GI has the potential to deliver a wide range of social, environmental and economic benefits at the multiple scales (TLI, 2009) (Austin, 2011). The context of green infrastructure is generally suburban and urban, but optimally connects to more natural and fully functioning ecosystems. The principles that form the basis for the concept of green infrastructure have arisen from multiple disciplines including "planning, landscape architecture, ecology and conservation biology,



Map illustrating proposal for London National Park City - a green infrastructure vision for future London
Urban Good

forestry, and transportation.” (Firehock, 2015). Although widely promoted as having potential to improve urban environmental planning, GI still remains a broad concept.

The term has multiple meanings in terms of scale - from national and regional ecological networks, urban area green networks, to small scale stormwater management systems (Hansen and Pauleit, 2014). This report attempts to highlight key principles that have most often been associated with GI and that offer opportunity for implementation in answering the main research question.

Key principles of green infrastructure are as follows:

Integration

Green infrastructure planning approaches take urban green or green spaces as infrastructure and seek integration and coordination with other urban infrastructures (built-up structure, transportation) in terms of physical and functional relations to provide synergistic benefits through multifunctionality (Lovell and Taylor, 2013) (Hansen and Pauleit, 2014).

The ‘greening of infrastructure’ is essential in contributing to innovation and to sustainability. As opposed to grey infrastructures that are often calibrated to provide for single functions, the GI approach involves the intertwine/combining and integrating multiple sustainable functions to the built environment.

This integration could involve combining different functions at different spaces in a network, or stacking functions vertically in one, and could even include innovative scheduling strategies, such as “limited human use of hydrological systems during high flow periods” (Ahern, 2014).

Multifunctionality

Multifunctionality is one of the key concepts of GI. It may be understood as the multiple roles that GI ‘assets’ or elements provide. This notion of multifunctionality of GI assessments that they can deliver a diverse range of benefits which are mutually reinforcing. GI approach to land use planning promotes encourages that the same asset perform the widest range of functions for a greater range of socio-cultural, ecological, and economic benefits than that would have been possible otherwise (TLI, 2009).

GI approaches also provide for greater diversity at a landscape scale . Functionality is away to analyze functions and processes that maintain and work within a given GI asset or between assets in the landscape. Specifically, multi-functionality, has become increasingly important in the conversation of landscape development in relation to continued competition for economically incentivised land use development. GI approaches are an alternative to Grey infrastructure development and their focus on singular and profit driven development (Mell et al., 2007). Multiple functions increase cost-effectiveness and efficiency through multiple use and compact organization (Austin, 2014).

Ecosystem services

An important concept that supports the multiple functions that GI assets provide are ecosystem services - the range of services provided by ecosystems and their components (TLI, 2009). Ecological services include, among others, the regulation of climatic condition, cycling of nutrients, detoxification of wastes, and control of pests (ESA, 2006, as mentioned in Ahern, 2014). The ecosystem services concept helps to place value on ecological functions, often to the direct benefit of human populations in physical health, economic or social terms.

A partial list of the functions and services that GI provides are provided below (Kim et al.,

2019):

Socio-cultural Function

Improved built environment

- Reduced noise pollution
- Improved housing quality
- Improved access to public services such as green spaces

Educational opportunities

- Increased interaction with nature
- Increased awareness on environmental issues

Ecological Function

Runoff control

- Reduced downstream erosion
- Stormwater runoff management
- Flood control

Environmental resilience

- Groundwater recharge
- Habitat conservation
- Improved water and air quality
- Improved pollutant loadings
- Reduced ecological footprint

Economic Function

Enhanced economic capacity

- Improved marketability
- Increased property values and tax revenue
- Green job creation
- Reduced Energy Consumption

Spatial articulation

Another important element in GI as a planning approach is its spatial dimension. GI approaches employ spatial concepts from the principle of landscape ecology, recognizing pattern:process relationships, to guide and plan the spatial configuration of the landscape. This involves interventions that include the fundamental landscape elements of patches, corridors, and the matrix. The main approach is to conserve large blocks of habitat or patches of natural vegetation and to create connections and stepping stones between them (Ahern, 2014) (Firehock, 2015).

In addition to the specific landscape elements

derived from landscape ecology, articulating a spatial concept to guide, inspire and communicate the core of a plan or planning strategy becomes crucial in designing a GI system. Spatial concepts are articulated as highly imaginable and understandable metaphors which can support and inspire the planning process, such as the "garden city", "continuous productive city", and the "edge city". Spatial articulation through metaphors thus becomes a key principle through which rational knowledge is complemented with creative insights. This becomes essential for innovative planning, and can "structure and inspire the planning process, particularly with respect to achieving genuine and effective public participation" (Ahern, 2014).

Connectivity

Connectivity is another important element of GI where connectivity between different GI assets help maximize the benefits generated. Connectivity can be crucial in enhancing "public engagement with the natural environment, improve opportunities for biodiversity migration and assist in encouraging sustainable forms of travel" (TLI, 2009). This is also an effective approach to decreasing landscape fragmentation and increasing the stabilisation of the ecological systems of a given landscape (Liu and Taylor, 2002 as cited in Mell et al., 2007).

A high level of connectivity allows for migration of energy, people, finance and ideas and supports the development of more sustainable spaces (Hidding and Teunissen, 2002 as cited in Mell et al., 2007). Site scale elements, however environmentally beneficial, are not considered part of the green infrastructure if they are geographically isolated from a network of open-space corridors and spaces. This distinction emphasizes that connectivity between spaces large enough to support ecosystem functions and human use is a critical characteristic. This connectivity has positive implications for green

infrastructure(Meerow et al., 2016).

Here, connectivity refers to two types based on landscape ecology:

- structural - the spatial configuration of habitat patches
- functional - the behaviors of various species (Tischendorf & Fahrig, 2000 as cited in Meerow et al., 2016).

Urban Agriculture as Green infrastructure

The principles of green infrastructure thus have potential to re-conceptualize urban agriculture, from scattered and niche activities to an integrated component of a cities' urban fabric.

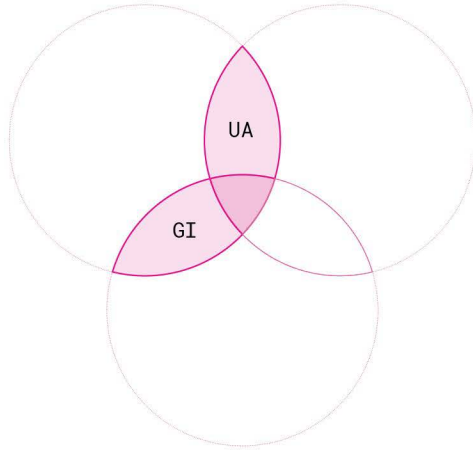
Integrating urban agriculture as green infrastructure pushes forward the notion that UA is an important component of a sustainable city and advocates for it to be integral part of planning and design. Doing so acknowledges that food and landscapes are mutually constituted and that connectivity will develop and strengthen this interdependence for increased benefits. Conversely, including urban agriculture and productive landscapes as components of a GI system adds food production and its associated benefits as additional functions of a cities' infrastructure while adding to landscape heterogeneity and also to the system's aggregated multifunctionality. This then also helps develop urban agriculture and productive urban landscapes gain spatial significance within the urban fabric. Finally, urban agriculture as green infrastructure expands the typologies of GI to include places of food production and creates new hybrid and multifunctional productive infrastructure.

Strategies

- Productive Green Infrastructure
- Strategies
- Components

3

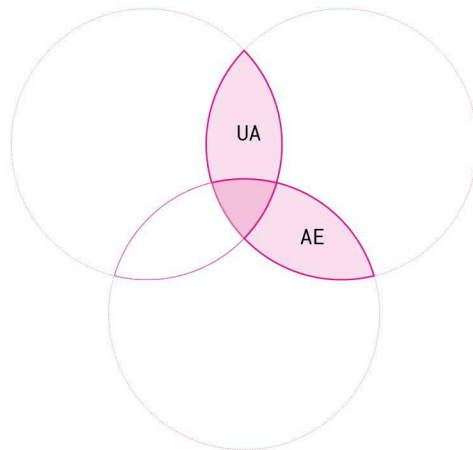
UA as GI



Integrating urban agriculture as green infrastructure

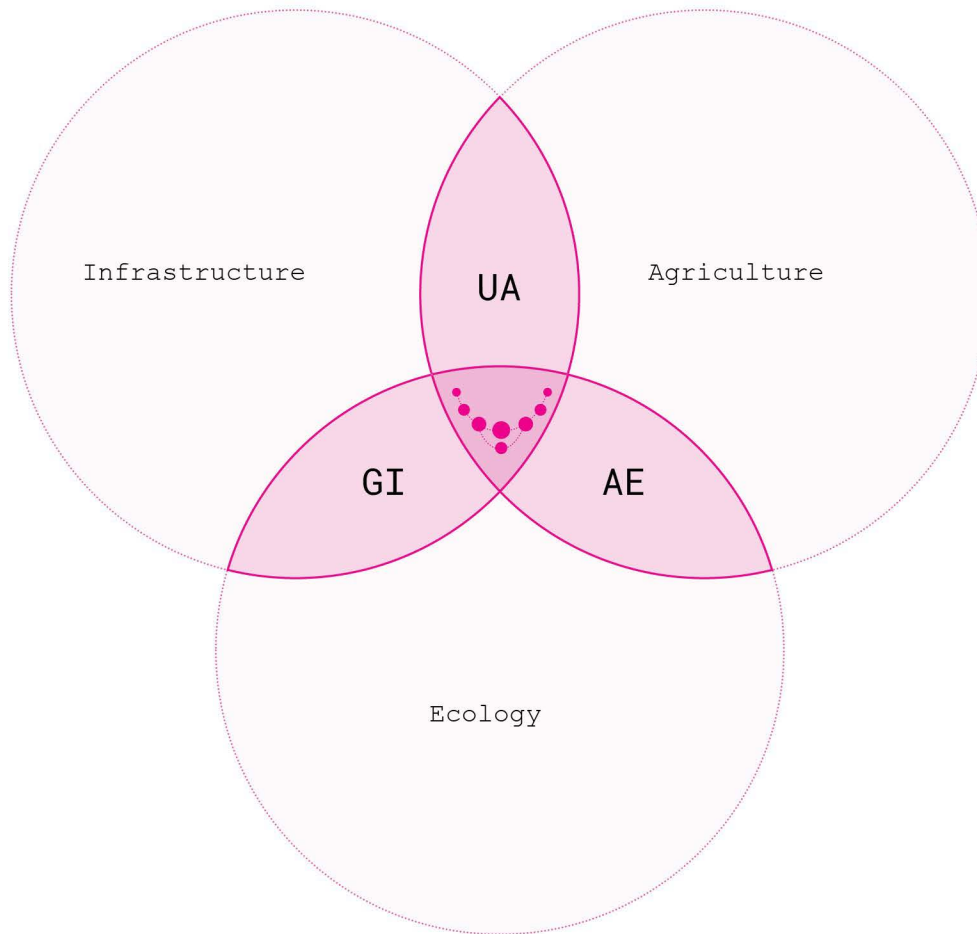
- Pushes forward the notion that UA is an important component of a sustainable city and advocates for it to be integral part of planning and design
- Acknowledges that food and landscapes are mutually constituted and that connectivity will develop and strengthen this interdependence for increased benefits
- Helps develop urban agriculture and productive urban landscapes gain spatial significance within the urban fabric
- Adds to GI's multifunctionality providing food production and its associated benefits as additional functions of a GI system
- Expands typologies of GI to include places of food production and creates new hybrid and multifunctional productive landscapes

AE in UA



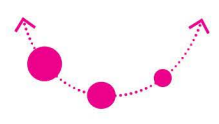
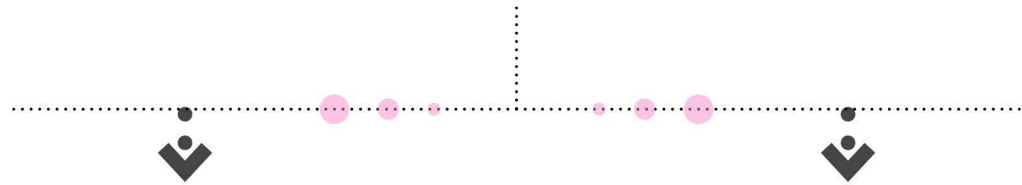
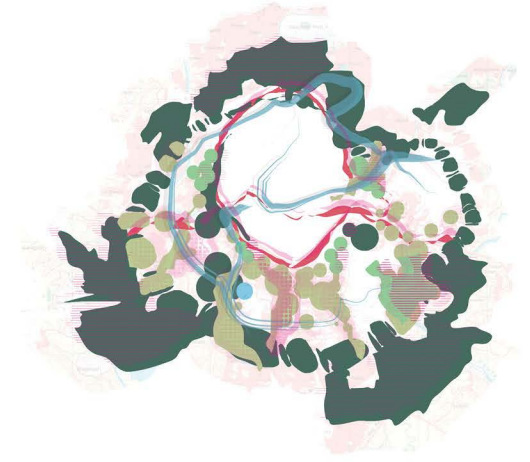
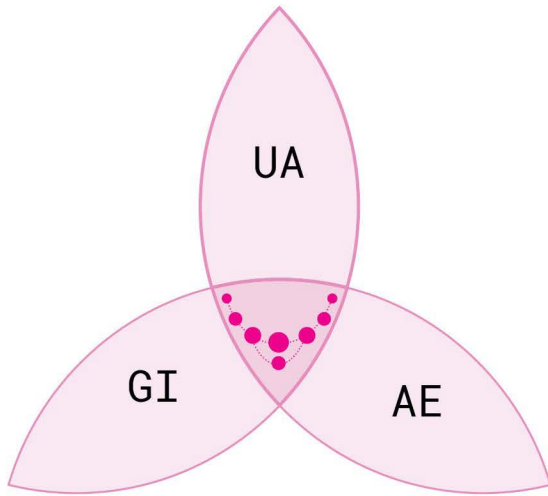
Integrating agroecology in urban agriculture:

- Can help realize productive potential of UA and create resilient urban food systems through management practices rooted in ecology
- Can enhance urban biodiversity and ecosystem services through the design of complex and diverse agroecosystems
- As a social movement, advocates for the right of citizens to decide their own food and farming policies and demands social transformation to achieve food sovereignty
- Reinforces positive contributions of indigenous peoples' and traditional food production systems
- Expands citizen participation and democracy in the co-production of knowledge , policies, and urban space

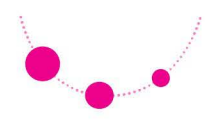


PGI
**Productive
Green
Infrastructure**

Together, these three concepts form a new model of infrastructure which I am referring to here as Productive Green Infrastructure or PGI - This incorporates ecology and food sovereignty into urban agriculture and integrates it as a part of an interconnected network



Strategies



Components

My proposal, the 'Hariyo Mala' is a contextual iteration of this model and is specific to the geographical context of the Kathmandu Valley.

This PGI system consists of several strategies and design components. The strategies were synthesized from green infrastructure and agroecology and relate to their principles here to the left.

Simply, they are ways that the principles can be achieved and guide how components create the PGI. I won't explain these in detail right now , but I show their empirical and context specific use in my design interventions.

Similarly, the components of the system include green infrastructure assets, urban agriculture typologies, and agroecology practices. These elements relate to different scales of intervention described here as meso or region/city, local, and micro scales.

And , it is the horizontal reading of these components at their respective scales that generates the Productive Green Infrastructure system.

For example,

At the Local scale, community parks could facilitate community gardens thus integrating food production as one of the multiple functions of the park. This could then be developed as a demonstration site where agroecological practices are developed and shared. This acts as an empowering infrastructure that also provides for example, access to technical knowledge and quality seeds.

Principles and strategies from the concepts of GI and AE are combined and translated to create a set of strategies that can be utilized to create a productive green infrastructure



Strategies

Principles

Integration

Multifunctionality

Connectivity

Spatial articulation

Agroecological diversification

Food sovereignty

Circular and solidarity networks

Empowering infrastructure

Strategies

Reframe UA as GI and integrate with other infrastructures

Plan for multiple functions incorporating food production as a key function

Create physical and/or functional connections between productive landscapes and other GI assets

Combine spatial concepts from GI planning with food as metaphor to guide and inspire planning

Design for complex and diverse agroecosystems based on principles of ecology

Guarantee people's access to resources to define their own food systems

Strengthen short chain community food networks and develop closed-loop systems

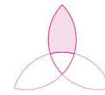
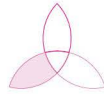
Facilitate adequate urban infrastructure to build farmer resourcefulness

GI

AE



Components



GI Assets

UA Typologies

AE Practices



Meso Scale

Region
City



Scenic vistas
Forests
Green ways / Greenbelts
City parks
Sports complex / recreational grounds
Water bodies and waterside areas
Non-vegetated / bare soils / sands
Nature Reserves
Grasslands
Green links
Golf courses
Strategic and long-distance trails
Urban Commons

Periurban farmland
Forageable corridor
Ecotourism farms
Cultural landscape farms
Pasture land
Commercial farms
Edible hotel landscapes
Agricultural estates

Land trusts
Diversified agricultural landscapes
Agroecological territories
Closed loop networks
Short food chains
Provision of public goods

Local Scale

Neighborhood



Community forests
Community parks
Institutional grounds
Religious complexes
Historic interpretive sites
Brownfield lands

Neighborhood food landscapes
Institutional gardens
Community farms
Community gardens
Multifamily farms
Allotments
Orchards
Wellness gardens
Victory gardens
Demonstration gardens
Food forests

Community land trusts
Agroforestry
Community food networks
Farmer to farmer networks
Food hubs
Agroecological lighthouses
Increase access to land, biodiversity
Co-creation & sharing of knowledge

Micro Scale

Site



Pocket parks
Private gardens
Town and village greens and commons
Rain-gardens / bio-filters / bioswales
Green roofs and walls
Green streets and alleys
Street trees, verges, hedges
Local right of way
Vacant and derelict land

Right of way gardens
Private roof gardens
Vertical gardening
Kitchen gardens
Balcony gardens
Container gardens
Berry patches

Crop diversification
Crop-livestock systems
Crop rotation
Crop-fish system
Multicrop farming
Covercropping



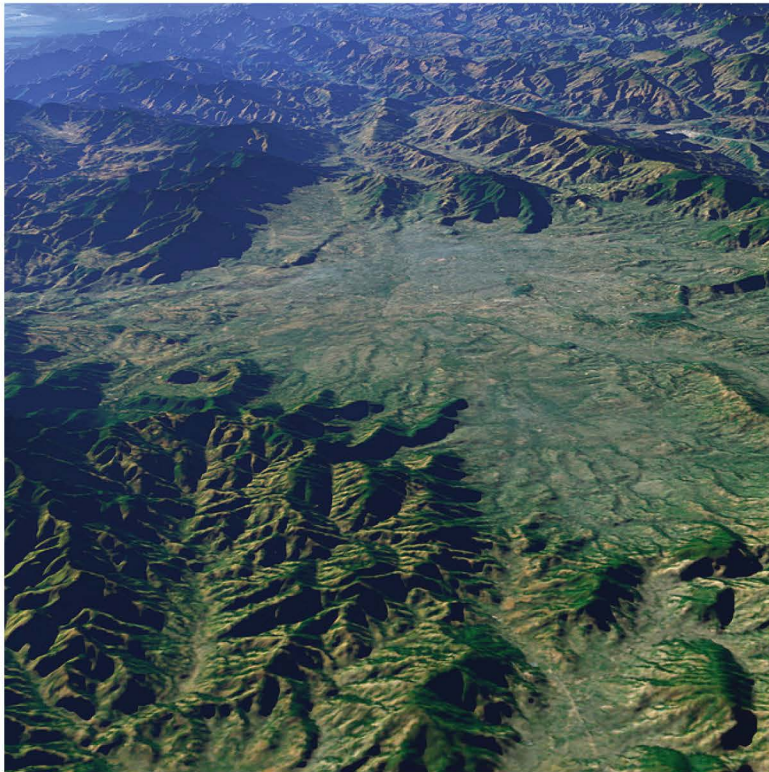
Study Area

- Kathmandu, Nepal
- Rapid Urbanization
- Impact on agriculture
- State proposed infrastructure

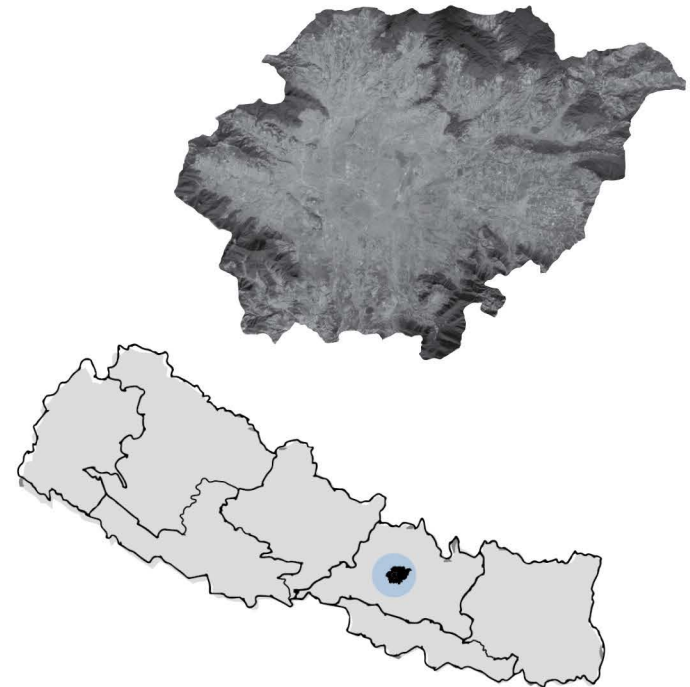
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Kathmandu, Nepal

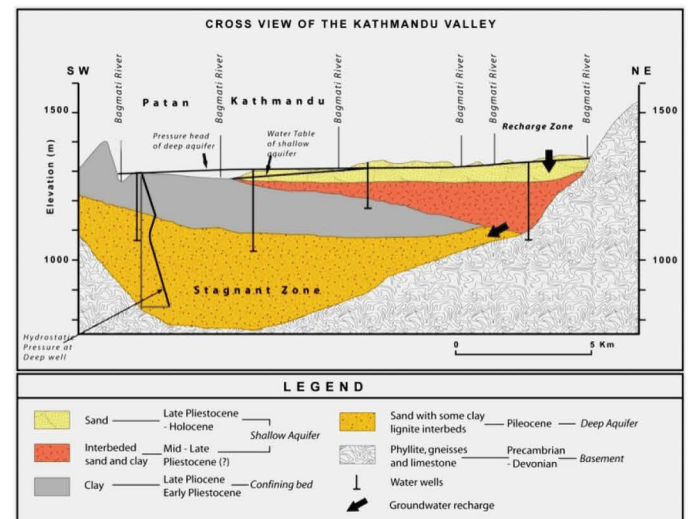
Over the last few decades, Kathmandu has gone through considerable social, political, and environmental transformations. Historically the hub for Nepal's urban development, the valley, starting from the 1970s has seen one of the fastest urban growth rates in the world (Manandhar, Parajuli, 2015) and continues to grow rapidly till this day. As a consequence of unplanned urbanization; loss of green open spaces, unprecedented pollution of waterways, and failing infrastructure are daily realities for the people. Kathmandu's food systems in particular are increasingly subject to the effects of a diminishing food shed, loss of agricultural identity, and other stressors such as natural disasters and climate change.



45-degree view of Kathmandu Valley
Christoph Hormann



Kathmandu Valley (Top)
Map of Nepal with Kathmandu Valley highlighted (Bottom)

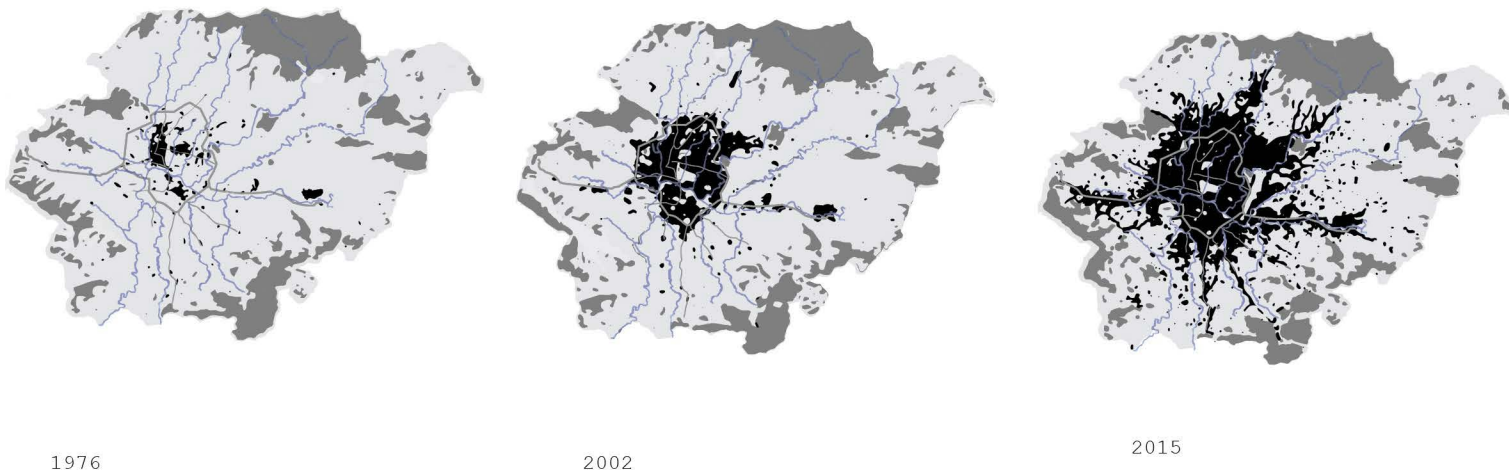


Conceptual cross section of the Kathmandu Valley
Creswell et al., 2001 in Davids, 2019

Rapid Urbanization

The abolition of the Rana regime in 1951 marked a political awakening and the beginning of a democratic transition in Nepal, and the country opened up to the world again after 104 years of autocratic rule. With the construction of two major highways in the following decades: the Tribhuvan Highway in the 1950s and the Araniko Highway in the 1960s, the country further solidified its connections to India and China (Thapa et al. 2008). The highways served as important corridors connecting key towns and cities to the Kathmandu Valley. They were also instrumental in facilitating the in-migration of people seeking to come to Kathmandu, where historically, political, economic, and cultural opportunities have most always been concentrated (Dixit et al. 2014) (Thapa et al. 2008).

Over the years, due to its centrality, the valley has continued to be a key gravity center for rural to urban immigration and has subsequently experienced rapid urbanization. Over the last three decades, built up areas increased by 412%, the majority of which occurred during the Nepalese Civil War. In 2011, the population of the valley was estimated to be around 1 million, and is projected to double by 2030 (Ishtiaque et al. 2017). The valley has continued to grow till this day, albeit not as vigorously, with development in a concentric pattern along the major roads at the expense of agricultural land conversion. Decades of political instability however have meant that this growth has not been sustainable and the existing institutions, policies, and have been unable to keep up with the changes. Although several development plans have been developed for the valley, barriers of institutional fragmentation, conflicting jurisdiction, and inadequate public investments prohibit their implementation. Lack of access to water, intermittent power supply, and subpar solid waste management are some of the pressing infrastructural deficits in the valley (Muzzini et al. 2013) (Dixit et al. 2014) (Thapa et al. 2008).



Urbanization in the Kathmandu valley
Increase in built up environment is followed by a loss in agriculture land

Adapted from Rimal et al., 2017

Impact on agriculture

Nationally, agriculture is an integral part of Nepal's economy, making up one third of the GDP. The sector provides employment to almost two thirds of the total population and livelihood to around three fourths. However, agricultural production has continued to decline, over the years and since the 1990s, the country has experienced a macro level food deficit. Today, many people suffer from food insecurity and spend a significant amount of their earnings on food (IBN, 2015). Nearly 41% of the population lacks access to the minimal calorie intake, and the country struggles in meeting standards of food safety, nutrition, and diversity (GoN, 2018).

Similarly, in the past, agriculture within the Kathmandu Valley was sufficient in meeting the overall food needs of the people and is assumed to have been able to supply up to one quarter of its demand for vegetables (Dixit and Bhandari, 2003; Baniya, 2008; as used in Dixit et al., 2014). This has not been the case in the recent years, however. According to the KFWVM's annual report, only about 8 percent of the all produces come from within the valley. The remaining amount is imported from elsewhere in the country as well as from the neighboring countries of India and China, displaying a significant dependence on regional and international market systems. This reliance on long distance transport of food has meant, time and again, increasing and often extremely fluctuating food prices.

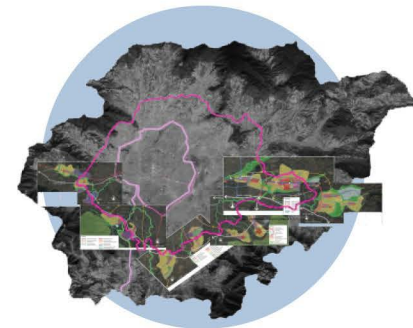
Adding to this vulnerability are concerns of natural disasters such as floods and landslides induced by climate change. As for production within the valley, increasing rates of urbanization over arable land and land fragmentation continue to put pressure on productivity. Available literature shows that over the last decades, immense development pressures have resulted in the expansion of built-up areas by four-fold with a proportionate reduction of non-built areas (Dixit et al., 2015 as used in Dixit et al., 2014). Today, with the exception of the odd vacant land here and there, agricultural land has been relegated to the peripheries of the valley. There is also a pressing need for drastic improvements in infrastructure and facilities. Food production is still primarily reliant on the annual monsoons with limited year-round irrigation facilities (IBN, 2015). Where once traditional irrigation canals compensated for inadequate rainfall, today farmers are reliant on mechanical systems. Moreover, the increase in nonagricultural uses have deprived downstream agricultural use (Dixit et al., 2005 as used in Dixit et al., 2014). Similarly, there is an increasing dependence on new and hybrid seed varieties.

This along with an increased usage of synthetic fertilizers and pesticides have reduced crop diversity and outcompeted the usage of traditional seed varieties. There is a potential risk of a loss of these traditional and local seeds and loss of plant genetic diversity as well as agrodiversity and traditional knowledge. In terms of governance, as elsewhere in the country, policies and amendments to date have largely failed to resolve issues regarding agricultural land (GoN, 2018). Lack of coordination among agencies, weak implementation initiatives, failure to prioritize agricultural extension services over competing interests, and failure to prevent artificial price escalations, are examples of poor governance that have added to and have compounded on existing vulnerabilities to the valley's food system (Dixit et al, 2014).

State proposed infrastructure

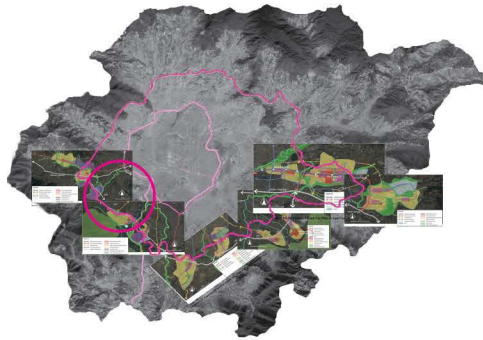
Among the numerous development works proposed by the state, an important infrastructure proposal within the Kathmandu Valley has been the Outer Ring Road Project (ORRP)- a 72 km stretch of road encircling the valley which is envisioned by the state government as an integrated infrastructure corridor serving as the backbone of urban growth in the future. The ring road has been championed as a mechanism for controlling urban sprawl, easing existing traffic and increasing capacity for future traffic, improving connectivity and flow of goods and services, and integrating existing three city centers within the valley. It is proposed to be 50 m wide with an additional 250 m on both sides to be land pooled for urban development. (KVDA, 2016) (Shrestha, 2013) (JICA, 2017). Originally proposed in 2005, the project was suspended due to disputes with stakeholders. It was only in 2016 that the ORRP was brought back into consideration (Ojha, Anup, 2016). The proposals have however again been met with numerous protests from various groups either due to issues related to lack of appropriate compensation for acquisition of land, or by environmental groups raising concerns against the felling of trees for the road construction (Ghimire, Binod. 2019) (The Kathmandu Post, 2018).

The infrastructure projects have received pushback from the indigenous Newar Jyapus of Khokana, a traditional village in the outskirts of the valley. The state has allocated around 5 major projects near the village which include the ring road, and the fast track. The community has raised concerns of gentrification and destruction of their cultural heritage and has claimed that they were not included in the decision making process. Excluded from consultations and forced into unfair bargains, the residents of Khokana are worried about losing their home, their land, and their identity. Championed as projects of national pride, these infrastructure projects promise modernisation and development.



Infrastructure projects are proposed throughout the country, however everything is centralized in Kathmandu

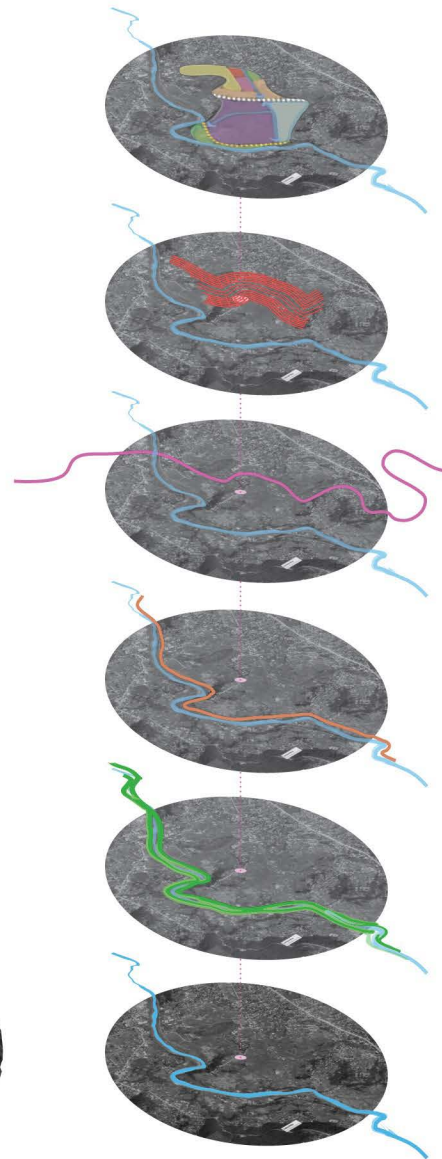
Speculative Outer Ring Road and new urban town proposals (JICA, 2017; KVDA, 2016)



Proposed infrastructure projects at Khokana, a traditional settlements



Infrastructure projects including a new outer ring road project threaten to displace indigenous communities from their land.



Speculative vision for new urban development

Land pooling on sides of ORR for urban development

Outer ring road

Fast-track highway

Buffers for Bagmati Restoration Project

Bagmati River

Multiple infrastructure projects proposed at the same location in Khokana



Timeline showing proposal of the Outer Ring Road (ORR) following new constitution and subsequent protests against them

Projective Design

- Design proposals and visioning
- Hariyo Mala
- Taudaha Sanglo
- Taudaha Agroecological Lighthouse

5

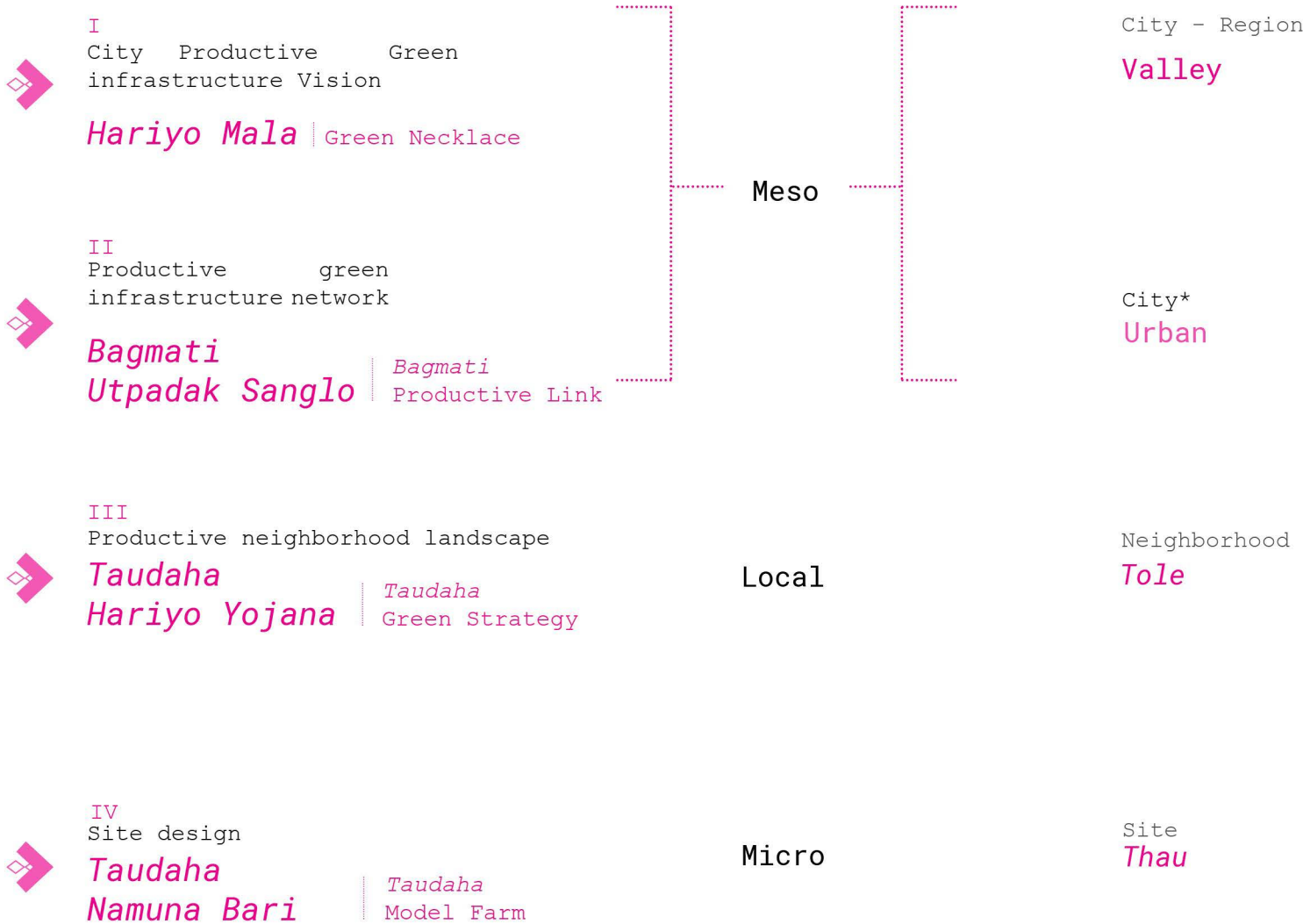
Design proposals and visioning



Proposal

Scales of intervention

Administrative divisions (Nepal)



I

Valley wide green infrastructure visioning

The existing Kathmandu Valley - urban development is concentrated at the core and is expanding towards the periphery. As urbanization continues, open space and agricultural land are being fragmented, taken up and converted. While small fragments of conserved forests remain at the outer edges of the valley, planning approaches as they are now fail to think of the integrity of the landscape as an integrated whole.



The Kathmandu Valley

Mala as a spatial metaphor for interlinked and interdependent productive landscapes and urban fabrics

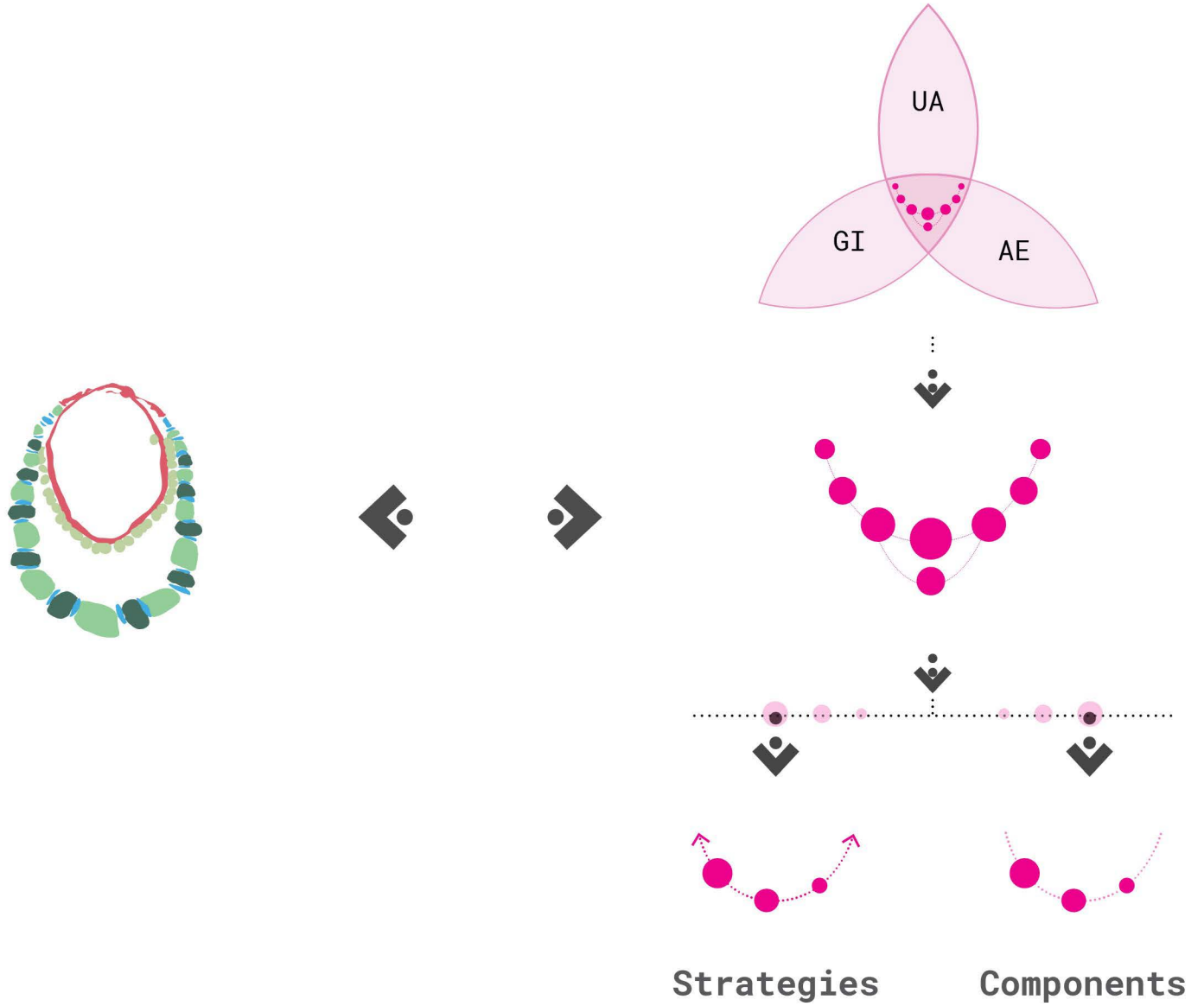


A woman from humla district wearing a Coin Necklace
Surendra Jabegu

What is a mala?

The *Mala* (Necklace) is an important part of Nepali culture having spiritual and social significance. It is used and is used in prayer, ceremonies, and during rituals throughout a person's life. Comprised of beads made from seeds, wood, stone, or of gems connected by a thread, the Mala represents a valuable personal artefact that one cherishes.

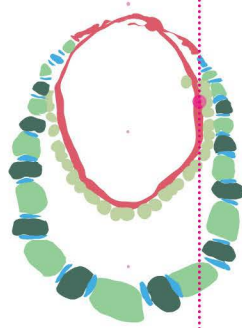
The *Mala* is taken as a metaphor to represent and project an interconnected system of natural resources, open spaces, built infrastructure, and waterways - landscape instastructure, which like the mala, is also valuable, cherished, and taken care for.



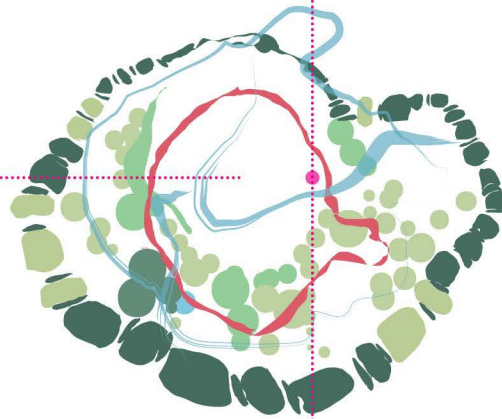
Developing the mala metaphor

The form of the mala is taken and further articulated referencing key landscape elements of the Kathmandu Valley:

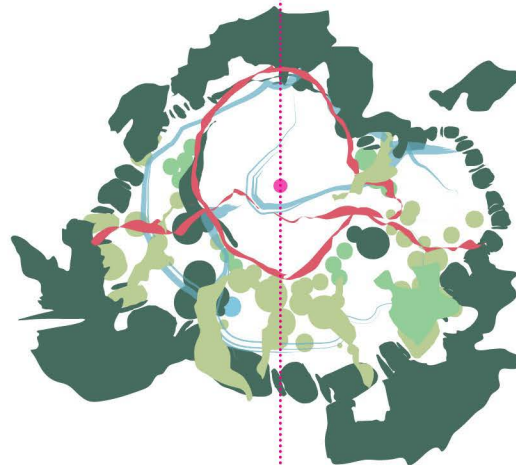
Conserved forests at the edge,
Farmland on the inside,
Built-up area at the core



A traditional mala is taken and its core elements are simplified - beads + thread



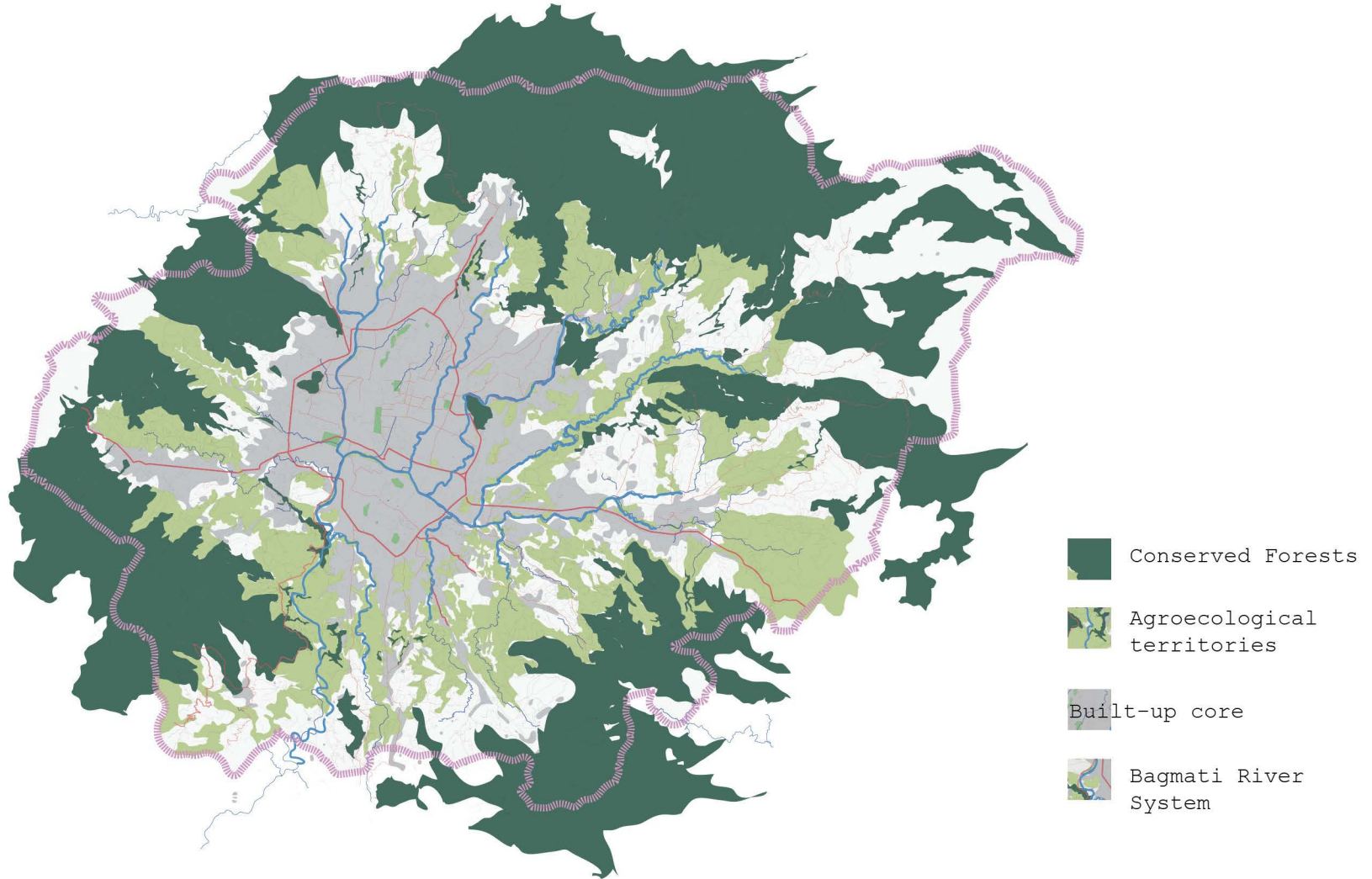
Roads and waterways become the connective thread linking the farmland and forests



The beads and threads further evolve to articulate and reflect the landscape elements of the valley

Hariyo Mala

Green necklace



The Hariyo Mala metaphor is developed to articulate and communicate the spatial concept of the

Hariyo Mala

a green infrastructure vision for a more sustainable and resilient future Kathmandu Valley.

It envisions a landscape comprised of concentric, interlinked and interdependent systems of conserved forests, agroecological productive territories, and built-up area, connected by nested hybrid productive green infrastructure

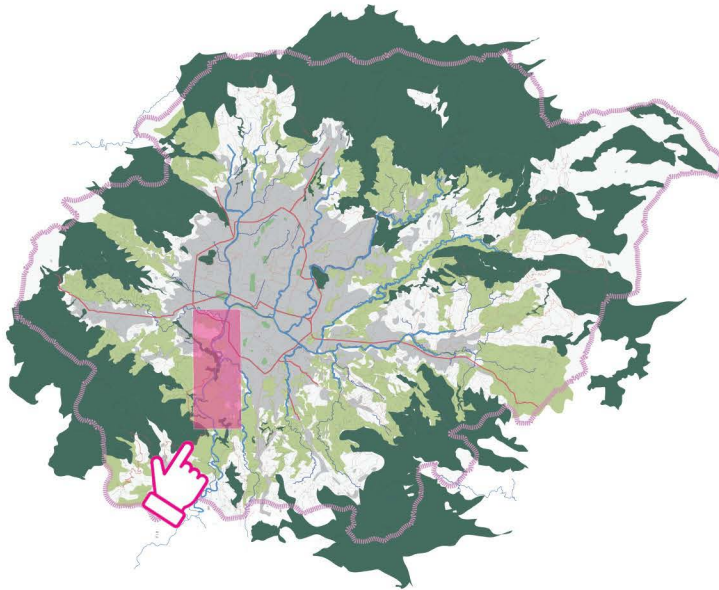
This hybrid productive green infrastructure will:

- Integrate places of food production as essential elements of future Kathmandu
- Include a diverse mosaic of landscapes that provide multiple functions and ecosystem services including food production as key function
- Connect *"outdoor spaces for food growing, leisure, movement and commerce shared by people, natural habitats, non- vehicular circulation routes and ecological corridors"*
- Include productive landscapes cultivated as complex and diverse agroecosystems
- Be conserved to provide access to communities to define their own models of food production, distribution, and consumption
- Support embedded short chain community food networks and closed-loop nutrient systems
- Improve adequate urban infrastructure to build resourceful farmers and communities

"The transect acts as tool to understand the agricultural functions along the rural-urban continuum." (Duany et al, 2011)

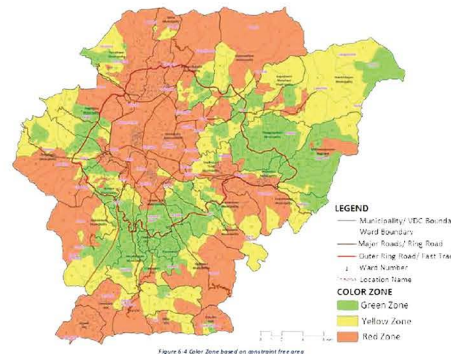
A link within the Hariyo Mala

The transect highlighted in Pink was selected for further investigation for the following reasons:



The transect

- Comprises of multiple open spaces designated for use in emergency situations by the state
- Includes areas proposed for designation as agricultural zone. See map below.
- Lies at the southern half of the valley where future urban development is expected to occur
- Comprises of periurban agricultural land important for the food production in the valley
- Is along the Bagmati River - a culturally and religiously important yet degraded river in the valley
- Transect shows diverse geographies of the Kathmandu Valley - Hill/Forest, Traditional settlement, Suburb, Urban area
- Connects multiple religiously and culturally important sites

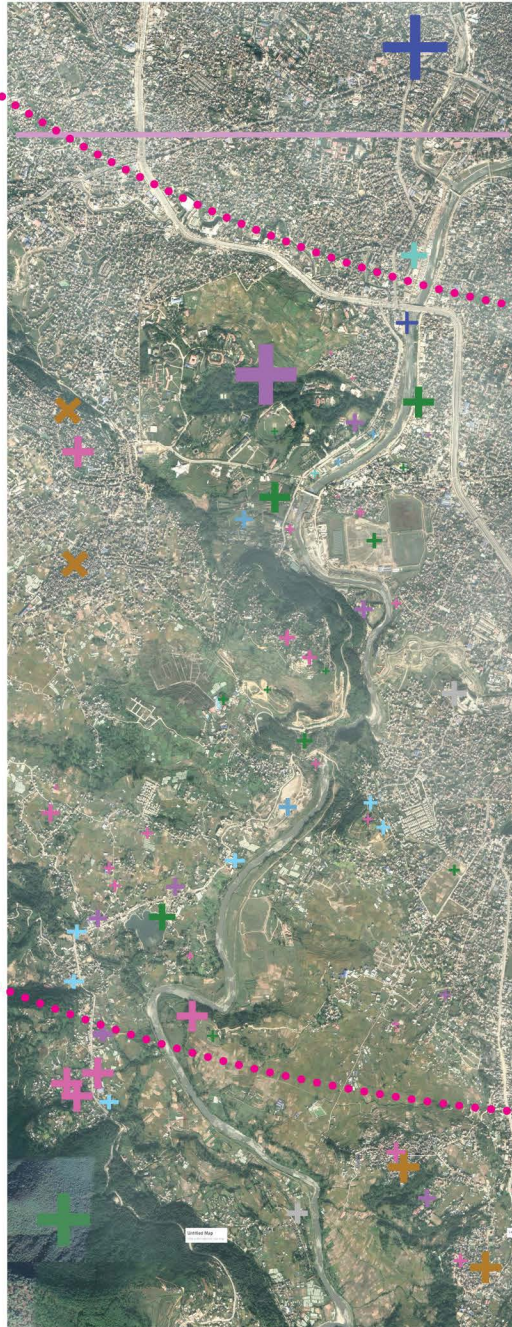


Speculative land use plan as proposed in *Kathmandu Valley 2035 and beyond: 20 Years Strategic Development Master Plan (2015 - 2035) for Kathmandu Valley*

Yellow and green zones were proposed to be designated as Agricultural area with restricted constructions

Aerial image of selected transect

- + Wholesale fruits and vegetable market
- + Government institutions
- + Educational institutions
- + Parks
- + Informal settlements
- + Religious
- + Traditional settlements
- + Forests, tree cover
- + Industry



Urban central area

Agricultural land are present on the outskirts of the urban central area. As the city continues to grow and expand, there has been an increase in construction on agricultural land outwards to the urban periphery and also inwards to the Bagmati River that runs through and drains the valley.

Urban periphery

Transect study

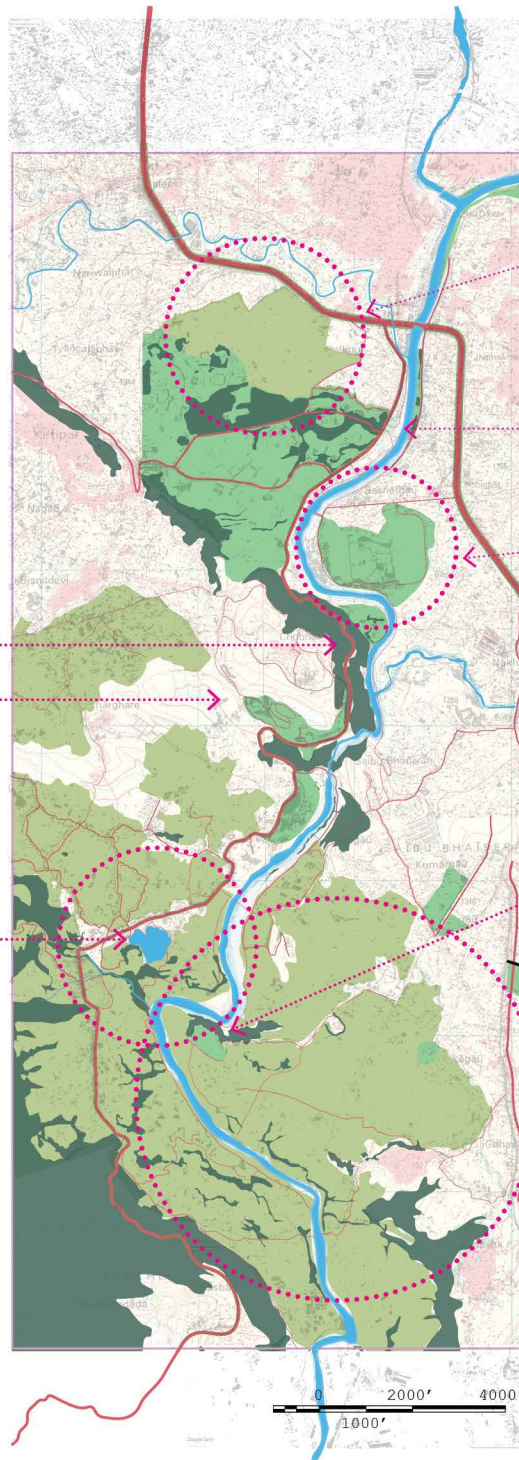
Existing conditions



Nepal to Hetauda Highway

Chobhar gorge
and Manjushree Park
Historic landmark tied to
the origin myth of Kathmandu

Taudaha
Ecologically important lake



T.U. khet



Farmland on the grounds of Tribhuvan University, the largest public university of Nepal

Bagmati river
Holy river that runs through the valley

Oxygenation park



Former aerating point currently used as a public commons

Srikali temple
Important Hindu religious temple and chaur

Khokana
A traditional settlement of the indigenous Newar people, historically famous for mustard cultivation



Key elements of proposal

Proposed productive land connected and protected from fragmentation



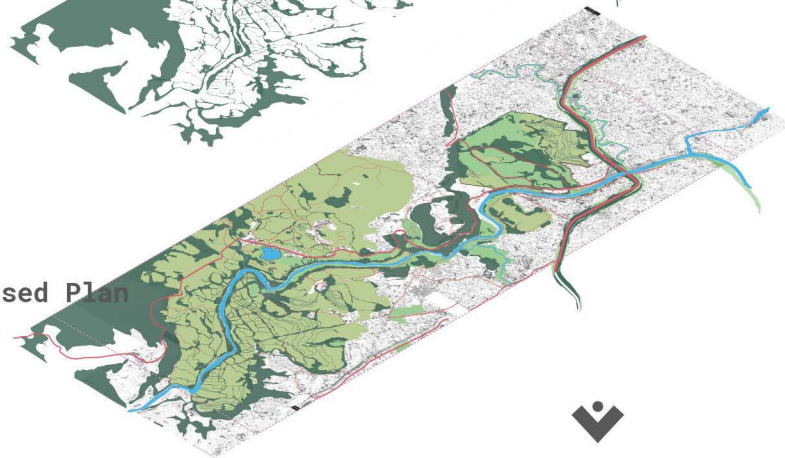
Proposed network of open spaces



Proposed forest cover



Proposed Plan



Strategies

Food sovereignty

- Conserve productive land through land trusts and prevent fragmentation
- Develop as agroecological territory

Empowering infrastructure

- Create a food hub at Taudaha along highway

Connectivity

- Open up river corridor to public
- Connect open spaces farmland, and cultural sites through walkable and forageable green corridor
- Add food productive functions to underutilized spaces

Agroecological diversification

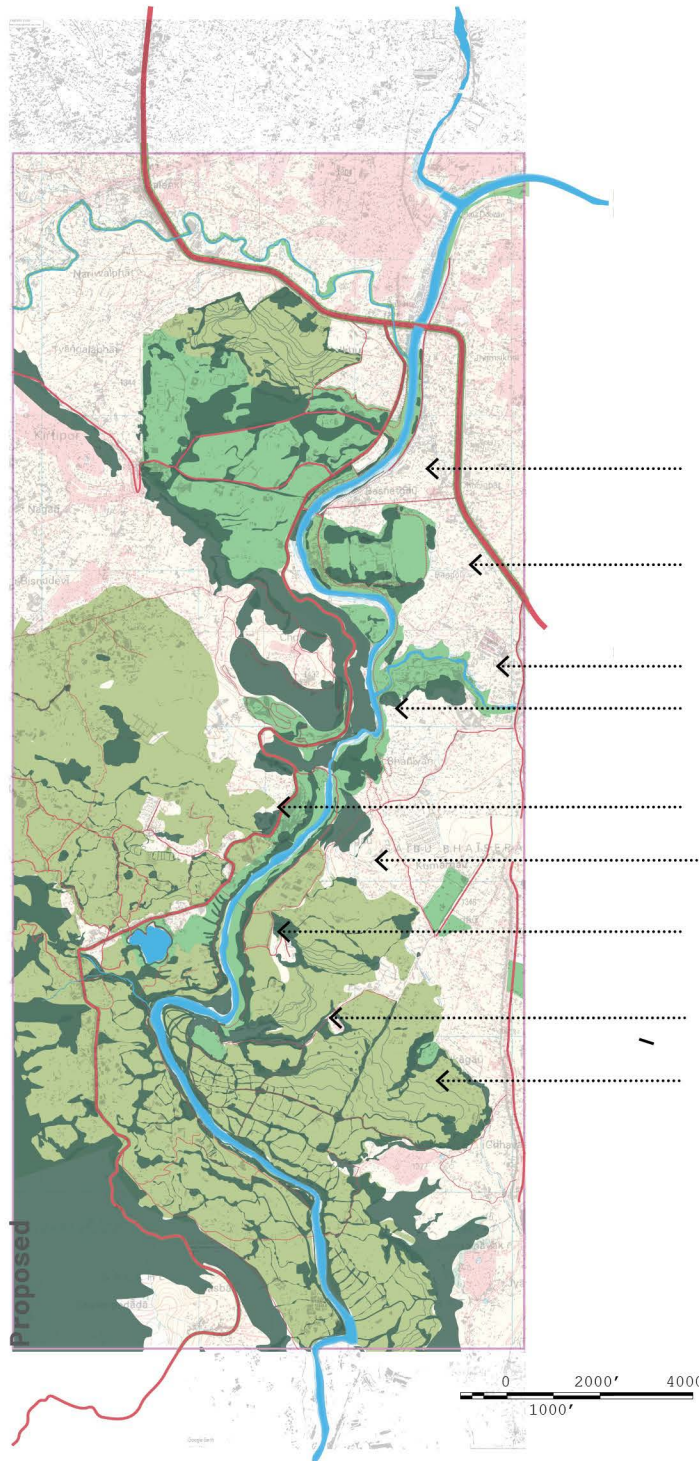
- Create and connect riparian buffers along river corridor with multipurpose trees
- Promote agroecological practices such as agroforestry, crop diversification, and edible hedgerows to increase productive urban tree cover

Bagmati Utpadak Sanglo

Bagmati Productive Link



- Agricultural land
- Other green spaces
- Road
- Underutilized vacant spaces
- Forest / Tree cover
- Built-up area
- Bagmati River



Components



Riverside park
+ Green links
+ Allotments



Neighborhood park
+ Designated open space
+ Raised bed community gardens



Constructed wetland



Babbar gorge scenic vista
+ Park
+ Urban forest



Commercial smallholder farms



Forageable green corridor
+ Pedestrian trail



Agroecological lighthouse
+ Land trust
+ Food hub



Pasture land
+ Riparian buffer



Cultural landscape farms
+ Agroforest hedgerows
+ Community forests
+ Agricultural wetland



Integration

Promote agriculture land as key green infrastructure asset; take 'Nepal to Hetauda' highway and Bagmati river as cultural and environmental anchors for interventions, incorporate food productive function to existing underutilized spaces

Multifunctionality

Enhance landscape heterogeneity by preserving/creating diverse mosaic of places that offer a wide variety of ecosystem services including food production as a key function

Connectivity

Connect fragmented productive spaces through GI, new road access, restored productive land, and canopy and plant cover

Spatial articulation

Use 'sanglo' as a spatial metaphor to guide and communicate design of greenway with important *ratnas/jewels*[nodes] along its network

Agroecological diversification

Promote agroecological farm management practices on productive land along Bagmati, including agroforestry and multicrop farming

Food sovereignty

Set up land trusts to prevent land fragmentation, protect and improve access to farmland and ensure land tenure for small land holders

Circular and solidarity networks

Create urban to rural nutrient loop where organic waste is collected from the city, brought to the food hub in Taudaha, composted and utilized in agriculture, and later sold to urban markets

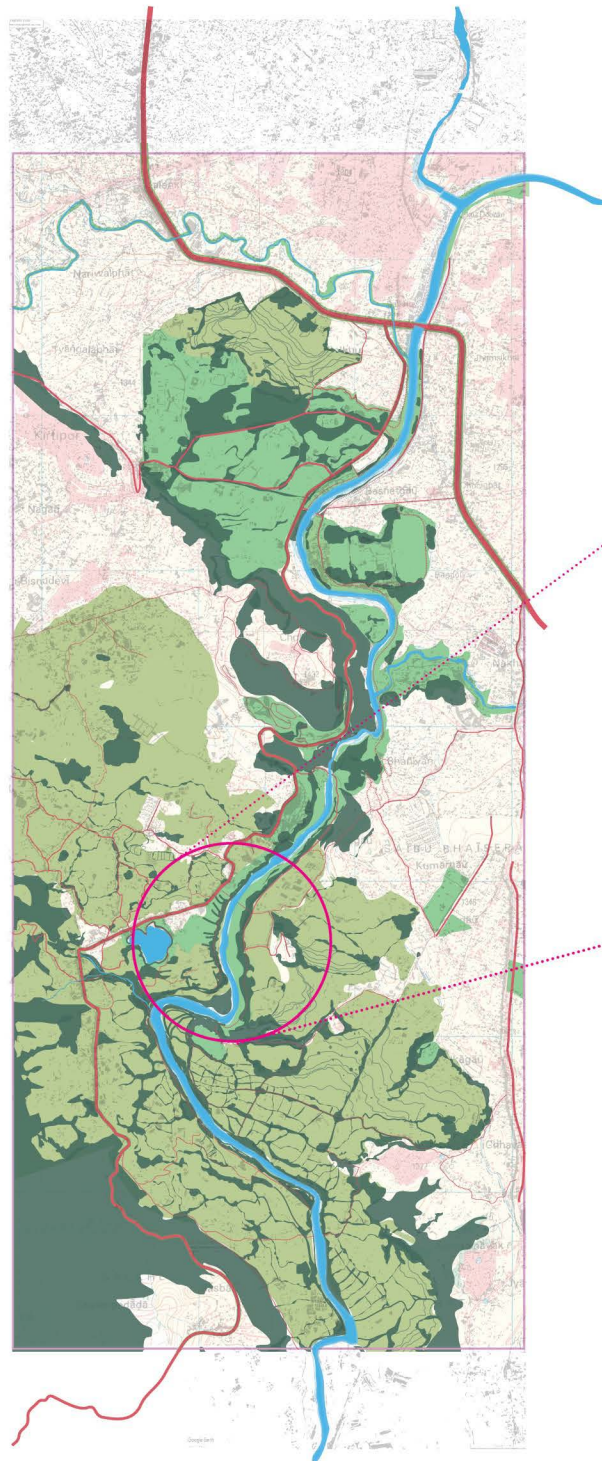


Meso Scale

GI Assets	UA Typologies	AE Practices
Forests	Forageable corridors	Land trusts
Green ways / Greenbelts	Community farms	Diversified agricultural landscapes
Green links	Cultural landscape farms	Agroecological territories
Trails	Pasture land	Closed loop networks
Urban Commons	Commercial farms	
	Vernacular agricultural typologies	

III

Productive neighborhood landscape



Taudaha

Tau: Snake *Daha:* Lake

The neighborhood of Taudaha which lies along the transect was selected for local scale investigation.



Nagpanchami ritual at Taudaha
Spotlight Nepal

Bar-headed goose
Somasekharan Sandeep

Taudaha is an important site along the transect and was selected for local scale intervention as it is:

An important religious and cultural site

- Believed to be a remnant lake of when Manjushree (a bodhisattva) drained the lake that once covered the valley
- According to the legend, Karkotak Nagraj and Nagrani (the King and Queen of Serpents) and Lord Ganesh reside in the pond and thus no fishing and boating are allowed till now.
- Various religious ceremonies performed at the site throughout the year
- Up to 500 internal tourists visit during the weekends

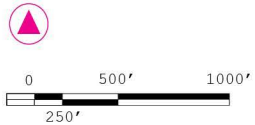
An ecologically important agricultural wetland

- One of the largest ponds in Bagmati watershed
- Seasonal habitat for hundreds of migratory bird species
- Constructed agricultural wetlands such as those surrounding Taudaha have historically been an important part of the Kathmandu Valley landscape. They have provided a range of ecosystem services including food production, retention of soil and the cycling of nutrients, as well as habitat for a variety of plants and animals.

Taudaha Neighborhood

Existing conditions

The neighborhood is primarily agricultural with small businesses situated along the highway. Taudaha is the main focal points drawing hundreds of tourists to the neighborhood. Several small restaurants have been built in the recent years around the lake.



- Blue cross: School
- Orange cross: Restaurants
- Green cross: Grocery Store
- Pink cross: Religious

Some of the environmental issues surrounding Taudaha have been an increase in construction of buildings around the lake, loss of forest cover, and contamination of the lake from the run off of agrochemicals.



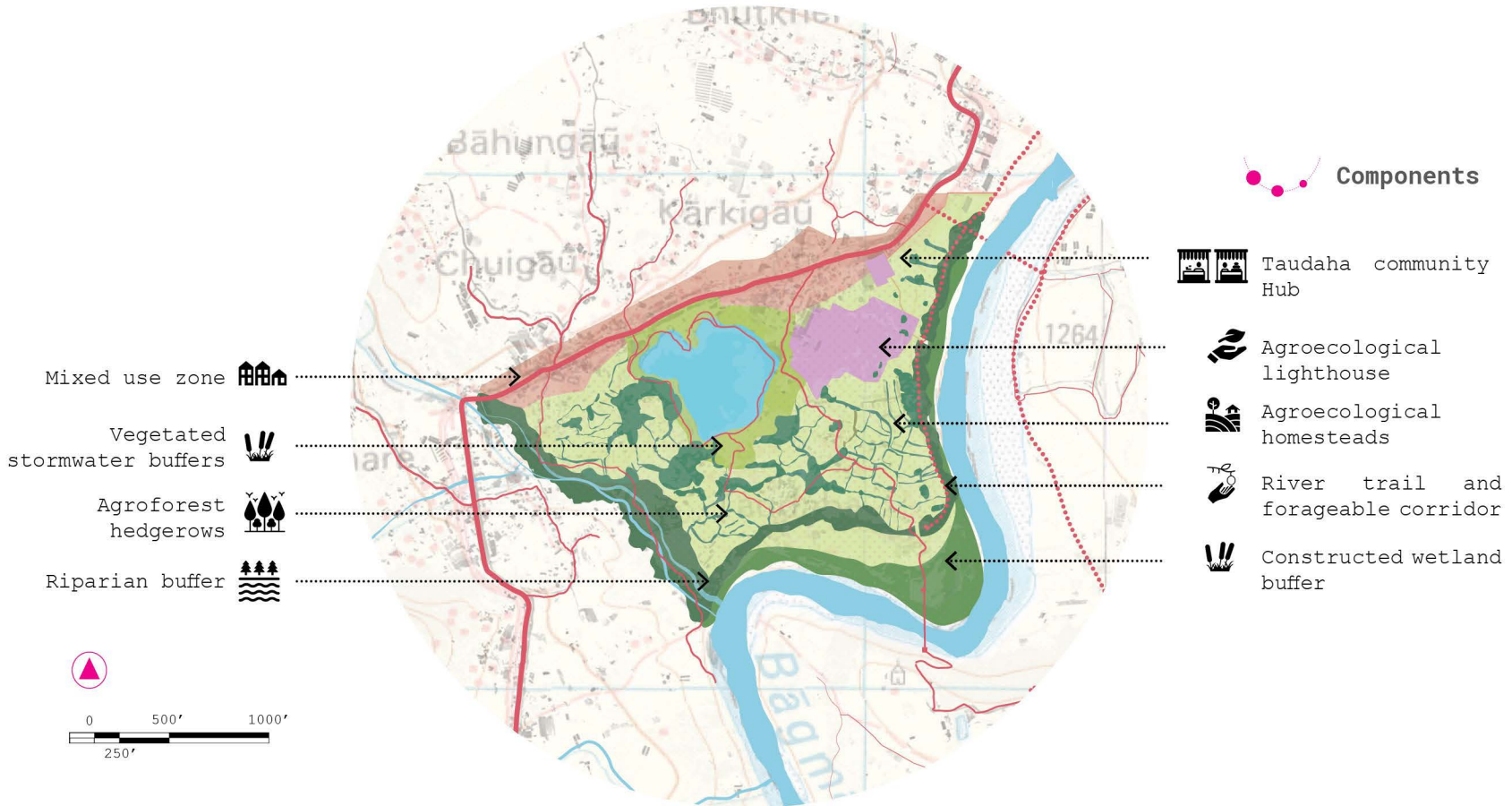
Integration	<ul style="list-style-type: none"> • Acknowledge kitchen gardens and farms as GI assets in neighborhood planning • Create stormwater filtration buffers and gardens along highway adjacent to and around Taudaha
Multifunctionality	<ul style="list-style-type: none"> • <u>Cultural</u>: Create an agroecological lighthouse as model farm for demonstration, training and for conservation of traditional seed varieties and farming practices • <u>Ecological</u>: Augment ecological functions by creating riparian and green buffers, wetlands, and integrated hedgerows; • <u>Production</u>: Promote agroecological farm management
Connectivity	
Spatial articulation	<ul style="list-style-type: none"> • Connect to larger green/foregable riparian corridor • Add connecting trails along riverside and provide access across Bagmati River to <i>Sri Kali</i> Temple and <i>Khokana</i> farmland
Agroecological diversification	Develop as key node/jewel of Bagmati Productive Lahar through conservation easements and land trusts
Food sovereignty	Work with farmers to prevent farm-land fragmentation, land grabbing, Provide access to seeds, diversity technical knowledge, and irrigation infrastructure
Circular and solidarity networks	Create closed loop cooperative networks of organic waste collection, short-distance transport, composting in local agriculture, and sale of subsequent produce to solidarity consumer groups
Empowering Infrastructure	Create community based and managed public food hub as part of local food network to aggregate logistical services and provides opportunities such as access to direct sales, warehouse, etc.



Local Scale		
GI Assets	UA Typologies	AE Practices
Community forests Riparian buffers Ridged terraces Wetlands	Foregable forest/corridor/windbreaks Multifamily farms / <i>Khet</i> Farm to restaurant gardens Terraced farming / <i>Bari</i> Edible hedgerows	Community land trust Agroforestry Food hub Agroecological lighthouse

Taudaha Hariyo Yojana

Taudaha Green Plan





Strategies

Food sovereignty

Land trust

- prevent farmland fragmentation
- ensure access to farmland

Empowering infrastructure



Taudaha Community Food Hub

- Aggregates logistical services
- Direct access to market



- School
- Restaurants
- Grocery Store
- Religious



Market in Kalimati, Kathmandu
Source: Manish Poudel

Proposed
Existing

Taudaha Food System



Where?

- Taudaha Model Farm
- Community agroforests
- Forageable corridor
- Family farms
- Family gardens

**Taudaha Model Farm

- Local food cooperatives
- Home production

**Taudaha Food hub

- Community supported agriculture
- Street vendors
- Solidarity consumers
- Local grocery stores
- Wholesale markets

**Taudaha Food hub

- Local farmers market
- Local grocery stores
- Wholesale markets
- Butchers
- *Chiya pasal*
- Restaurants
- *Khaja ghar*

**Taudaha Model Farm

- Organic waste collected from city core
- Biocomp Nepal
- Individual kitchen gardens
- Uphill communities

By whom?

- Neighborhood residents
- Leaseholder farmers
- Neighboring villages
- Women's cooperatives
- Farmer's cooperatives
- Taudaha management committee



Strategies

Empowering infrastructure



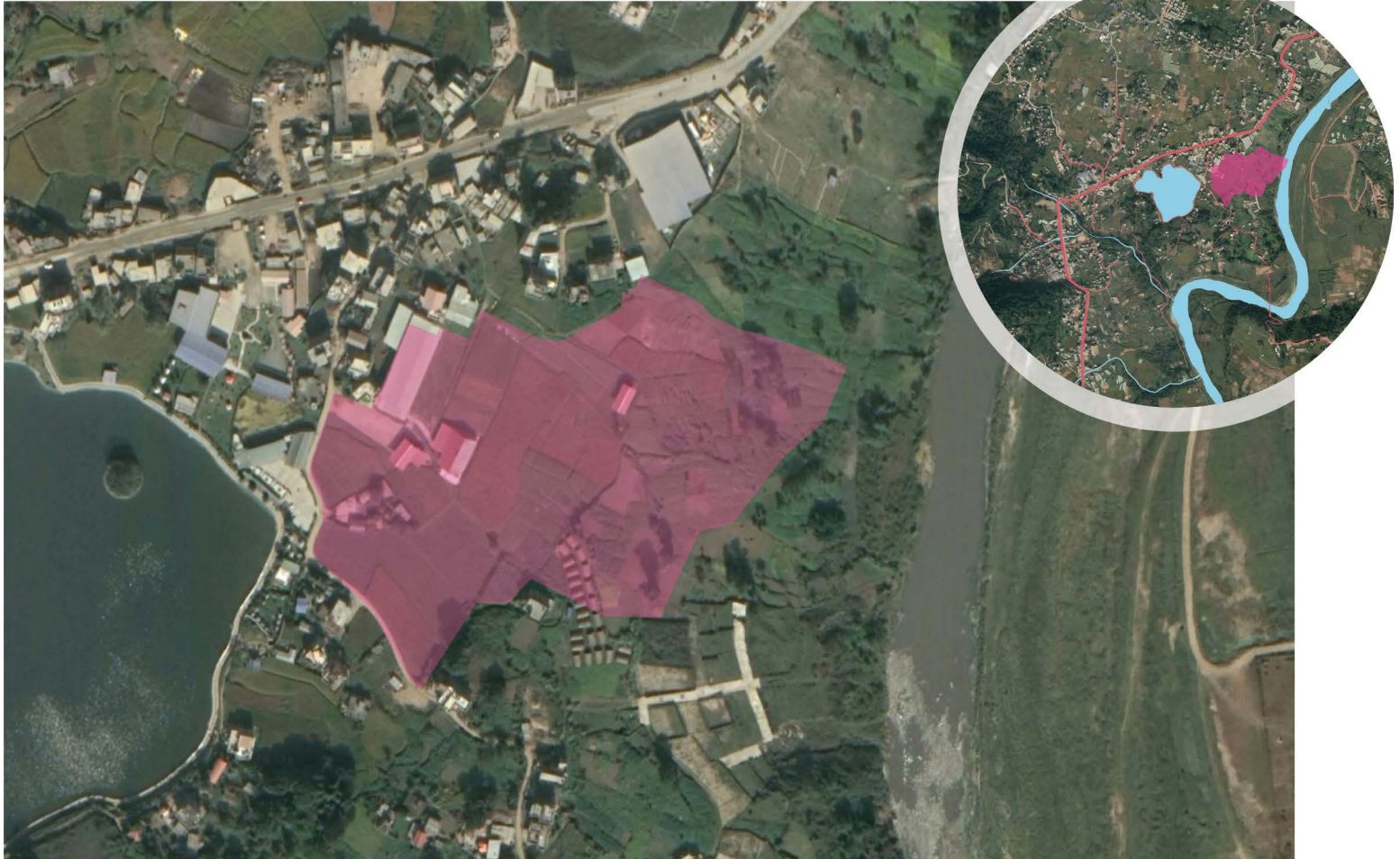
Taudaha Model Farm

Demonstration farm that provides field school for farmers on agroecological practices

- + Seed bank, diversity register
- + Community center



- + School
- X Restaurants
- X Grocery Store
- + Religious



The Site is approximately 8 acres in area. Adjacent to the lake, the site presents an opportunity for the protection of agricultural land from where agroecological practices can be developed and shared with the community thereby preventing excessive use of fertilizers, loss of farmland, and supports increase of forest cover and a diversified farming practice.



<p>Multifunctionality Ecological function Cultural function Productive function</p>	<p>Enhance biodiversity; improve soil fertility; reduce external inputs Develop a model farm for field-based learning and as community hub Provide dietary diversity and improved nutrients; supplement self provision capacity</p>
<p>Food sovereignty</p>	<p>Ensure access to farmland, seeds, and biodiversity; Support co-creation and sharing of knowledge</p>
<p>Agroecological diversification</p>	<p>Promote Agroforestry combined with multi-crop farming and crop rotation practices</p>
<p>Empowering infrastructure</p>	<p>Create seed bank, composting facilities, cold storage facilities, classroom, chautaris</p>

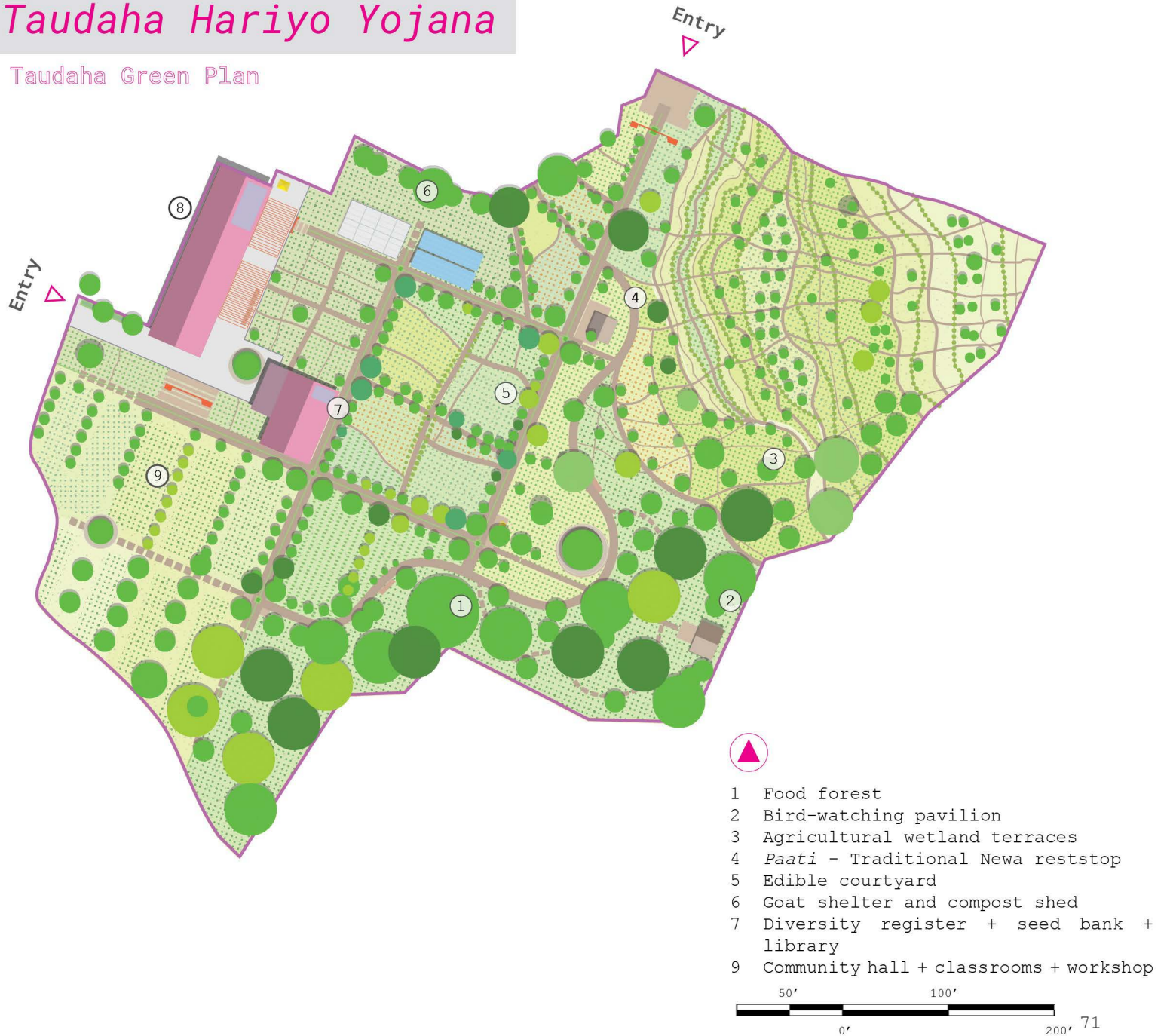


Local Scale		
GI Assets	UA Typologies	AE Practices
<ul style="list-style-type: none"> Passive irrigation Terraced fields Shrubs Trees Crops 	<ul style="list-style-type: none"> Community farm / <i>Khet</i> Kitchen garden / <i>Bari</i> Edible forest garden / <i>Khar Bari</i> Hoop house 	<ul style="list-style-type: none"> Develop as agroecological <i>lighthouse</i> Implement agroecological practices <ul style="list-style-type: none"> Agroforestry Crop diversification Inter cropping Crop rotations

Strategies and components utilized in the proposal

Taudaha Hariyo Yojana

Taudaha Green Plan



Description of proposal

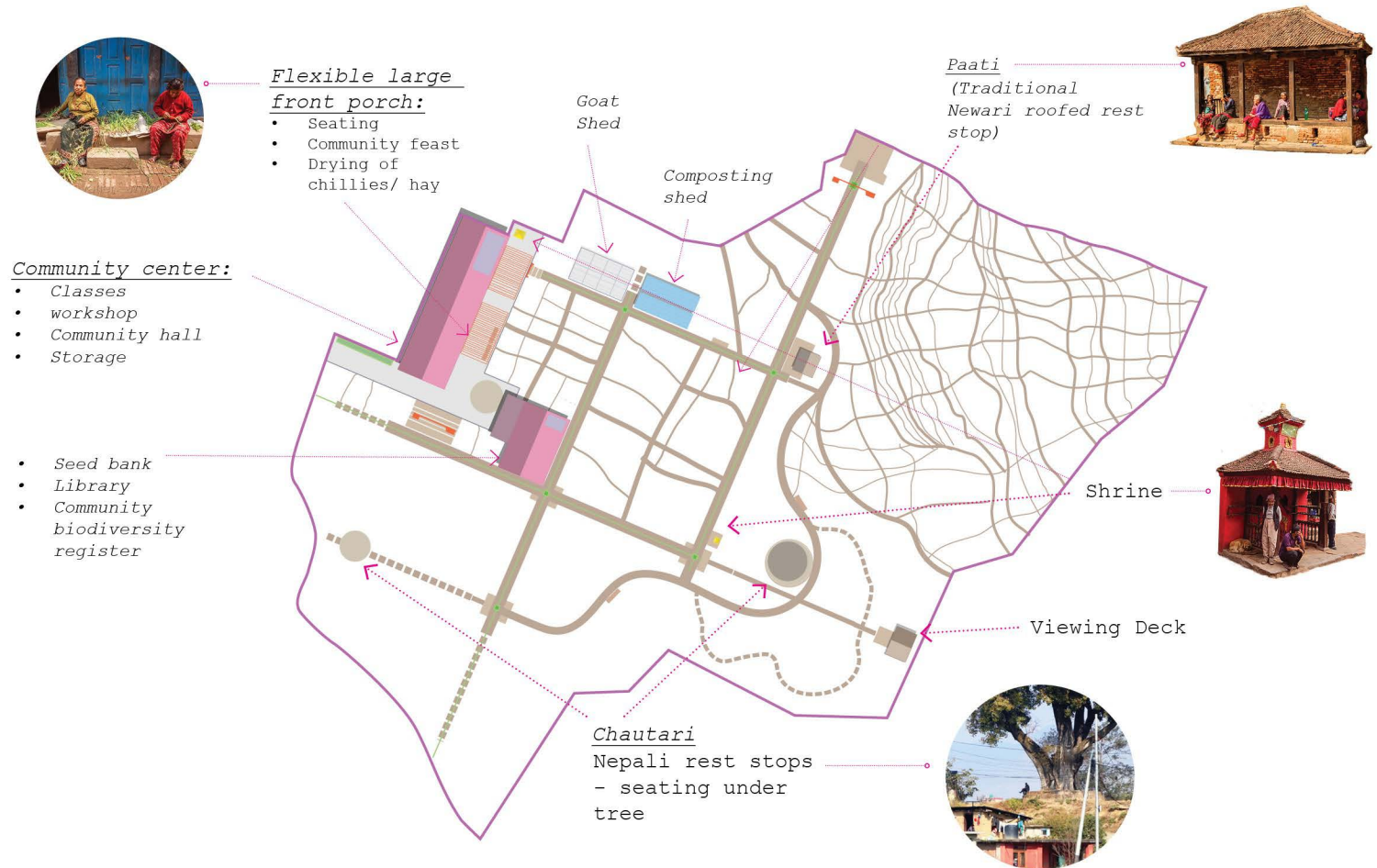
Agroecological lighthouse

- Demonstration farm to develop and disseminate sustainable agroecological farming practices
- Model farm showcasing different agroforestry practices
- Comprises of seed bank, library and community diversity register
- More productive and bio-diverse farming operation

Community hub with supporting infrastructure

- Center to build farmer to farmer solidarities and cross-cultural learning
- Democratic open space to engage communities towards social and environmental initiatives
- Serve as social safety net that provides for neighborhood in time of emergency

Built structures



Taudaha Namuna Bari will include new infrastructure to support:

Cultural functions:

classroom, library community hall, chautaris, paatis, shrine, for learning, social gathering and rituals

Productive functions:

irrigation system, hoop house, composting shed, cold storage, for more productive and sustainable farming

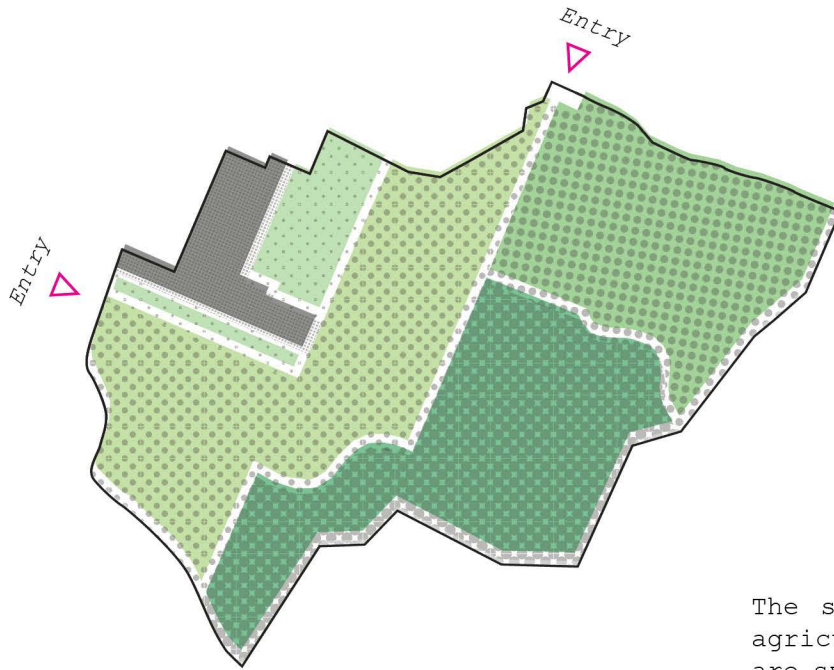
Ecological functions:

seed bank to store and maintain unique and rich local crop diversity as part of a decentralized community seed network

(Gauchan et al. 2002);

Community biodiversity register as a tool for communities to establish an inventory of crop diversity and to document its associated farmer (traditional) knowledge (Gómez et al. 2002)

Proposed Site Organization

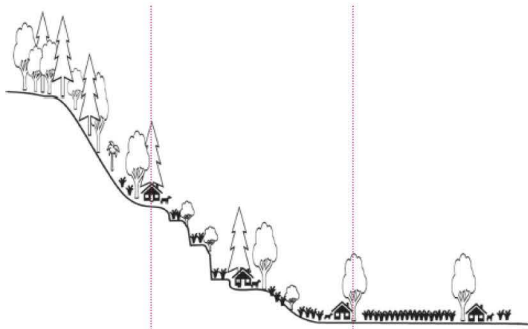


-  *Ghar / House*
-  *Ghar bari / Homstead Garden*
-  *Khet / irrigated lowland (flat) fields*
-  *Pakhabari / Separate fields upto 30 min walking distance*
-  *Kharbari / Forest*

The site organization represents different traditional agriculture practices of the mid hills of Nepal. These are symbolic but also allow for education and innovation of strategies suitable to each type of agriculture practice.

Baul et al. 2014
Cedamon et al. 2019

Traditional Nepali mid-hill agriculture



Kharbari Bari Khet

- *Ghar Bari*
- *Pakhabari*

Typology

Description

Pakhabari

- Very steep; Trees, woody shrubs, wild NTFPs
- Generally ploughing and seasonal cropping not practiced

Bari

- Moderate to steep; Cereals, fruits, vegetables
- Might be terraced; ploughing by animals
- Generally 2 cereal crops

Khet

- Flat, ploughing by animal or tractor possible
- Might have bunds
- 2-3 cereal crops, 2cereal crops + vegetable

Proposed Agroforestry approach

Agroforestry typologies



Peace Corps, 1990

Border planting

- For agricultural crops that require a lot of light, or are normally grown on flat areas
- Incorporate Nitrogen Fixing Trees
- Branches and leaves used as fodder, and as green manure

Sloping Agricultural Land Technology

- Controls soil erosion as well as produce one or several types of agroforestry products, such as fruit, corn, and/or vegetables.

Forest farming / Windbreaks

- Strip is formed by one or more rows of trees planted close together

Has multistory configuration with diverse species composition (Elevitch et al. 2018)

Alley cropping

- Strip is formed by one or more rows of trees planted close together
- Rows are planted along the contours to minimize soil loss

“Agroforestry is the integration of trees, plants, and animals in conservative, long-term, productive systems” (Martin et al. 1992)

Currently fertilizer intensive farming is practiced. Agroforestry could be a more sustainable alternative which could provide (Savanna Institute, 2019):

- **Diversified income/food security:** Trees and shrubs planted in windbreak can be cultivated as food, fiber, and fodder to be marketed or used for subsistence purposes
- **Higher land-use efficiency:** Tree roots capture nutrients that crops cannot access, thereby increasing the productive potential of the land.
- **Wildlife habitat and corridors:** Provides resources for pollinators and refuge for beneficial insects that control pests on farm
- **Carbon Sequestration** in woody perennials and soil organic matter.

Plant List Plant species utilized for food, medicine, ritual in the middle hills of Nepal.

This list can be used as a starting point in incorporating a more diversified suite of plants in farming practices in Kathmandu. Taking this list, the next step should involve working with local communities to identify and include local and heirloom varieties.



Canopy layer

Cinnamomum tamala
 Emblica officinalis
 Mangifera indica
 Prunus persica
 Prunus domestica
 Artocarpus lakoocha
 Dendrocalamus spp
 Bambusa spp
 Ficus benghalensis
 Terminalia belerica
 Aegle marmelos
 Rhus javanica
 Rhus succedanea
 Citrus maxima
 Citrus medica
 Diploknema butyracea
 Brassaiopsis glomerulata
 Garauga pinnata
 Cinamomum zelyanicum
 Juniperus wallichiana
 F. glomerata
 Erithrina variegata
 Bredelia retusa
 Premna integrifolia
 P. latifolia
 T. chebula
 Tamarindus indica
 Lucaena leucocephala
 Syzigim cumini
 Citrus spp
 Ficus Lacor
 Callistemon viminalis
 Myrica esculanta
 Artocarpus integrifolia
 Castanopsis indica
 Machilus spp.
 Acacia catechu
 F. semicordata
 F. cunai



Shrub Layer

Musa spp
 Persea americana
 Morus alba
 Mesua ferrea
 Cocos nucifera
 Pyrus communis
 Citrus spp.
 Prunus cerasoides
 Grewia
 F semicordata var montana
 Symplocos ramosissima
 Elaeocarpus sphaericus
 Artocarpus heterophyllus
 T. tomentosa
 Jatropa cureas
 Santalum album
 Mallotus philippensis
 Crataeva religiosa
 Dalbergia sissoo
 Moringa oleifera
 Citrus nobilis
 Ficus benjamina
 Bauhinia purpurea
 Diospyrus melanoxylon
 Ficus auriculata
 Ficus hispida
 Cedrela toona
 Citrus auratifolia
 Antidesma diandrum
 Psidium guajava
 Brassaiopsis hainla
 Punica granatum
 Lyonia ovalifolia
 Bauhinia variegata
 Murraya koenigii (L.)
 Cinnmorum tamala
 Cyathea spinulosa
 Litsea polyantha

Acorus calamus
 Calotropis gigantea
 Heynea trijuga
 Rubus ellipticus
 Adhatoda vasica
 Thysanolaena maxima
 Hibiscus rosasinensis
 Zizyphus jujuba
 Ananas comosus
 Jasminum arborescens
 Berberis asiatica
 Coffea arabica
 Woodfordia fruticosa
 Mussaenda macrophylla
 Gardenia jasminiodes
 Wendlandia coriaria
 Gossypium arboreum
 Entada scandens
 Nyctanthes arbor-trisis
 Eurya japonica
 Euphorbia royaleana
 Camellia Spp.
 Bougainvillea spp
 murraya paniculata
 Canna indica
 Justicia adhatoda L.
 Colebrookea oppositifolia
 Solanum melongena
 Solanum nigrum L.
 Yucca sp.
 Rauwolfia verticillata
 Justicia adhatoda L
 Tecoma stans



Herbaceous

Callistemon
 Nyctanthes arbor-tristis
 Chaenomeles Japonica
 Hydrangea
 Rhododendron
 Gardenia jasminoides
 Nerium oleander
 Jasminum Polyanthum
 Euphorbia pulcherrima
 Datura stramonium
 Agave americana
 Sapium insigne var. malabaricum
 Euphorbia pulcherrima
 Ocimum spp
 Mentha
 Mentha arvensis L.
 Valeriana jatamansi
 Acorus calamus L.
 Thysanolaena maxima



Rhizosphere

Solanum tuberosum
 Sweet potato
 Radish Raphanus sativus
 Turnip Brassica rapa L.
 Pumpkin
 Yam
 Zingiber officinale
 Allium cepa L.
 Valeriana jatamansi Jones



Groundcover

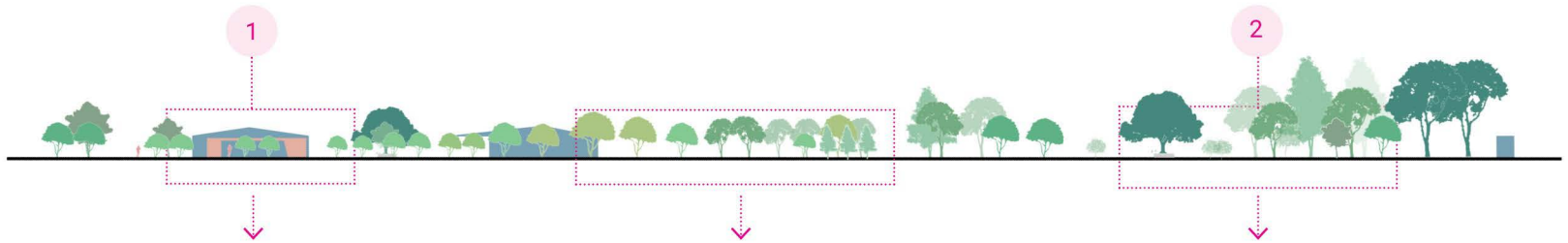
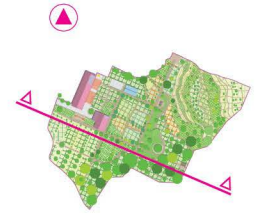
Eulaliopsis binata
 Typha angustifolia
 Girardinia palmata
 Pennisetum purpureum
 Brassica juncea L.
 var. rugosa
 Brassica oleracea
 Brassicaceae
 Spinacia oleracea
 Asparagus officinalis
 Trigonella foenum-graecum
 Canavalia ensiformis
 Brassica oleracea
 Amaranthus spinosus
 Agaricus bisporus
 Capsicum annum L



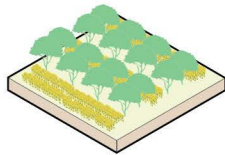
Vertical layer

Vitis vinifera
 peas
 Bauhinia vahlii
 Momordica charantia
 Iablab purpureus
 Lagenaria siceraria
 Pisum sativum
 Solanum lycopersicum

Site sections and perspective views

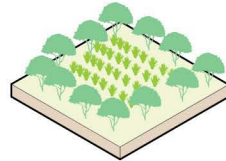


1
Orchard alley
Fulbari galli



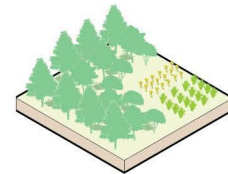
Row cropping model
Alternate rows of trees and food crops

2
Edible courtyard
Aangan-bari



Border planting model
Trees surround food crops on border

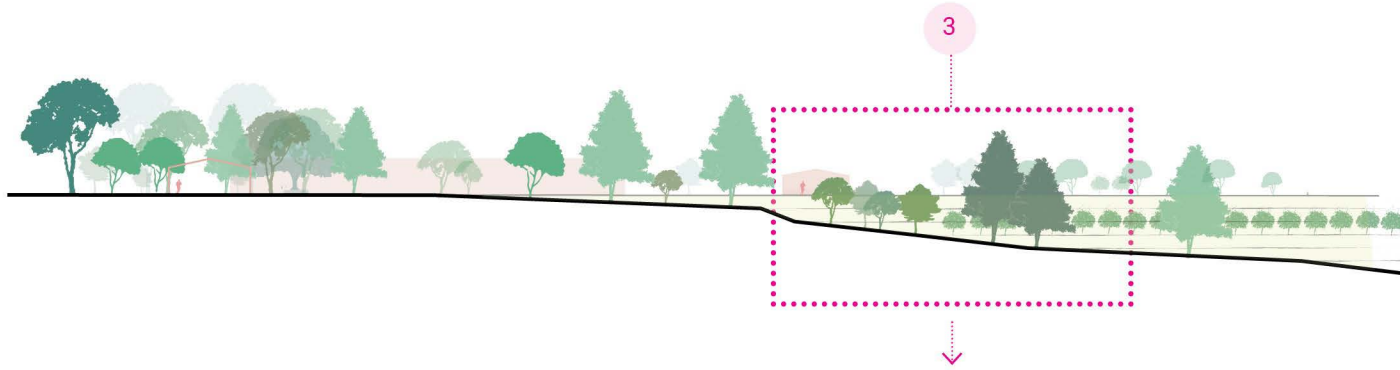
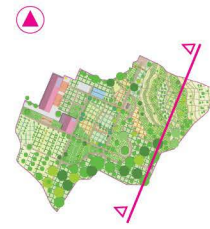
3
Food forest
Pakhabari



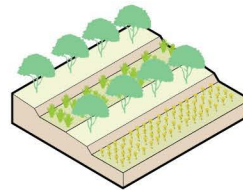
Forest farming / Windbreak model
Farming in the woods where multipurpose trees also act as a protective windbreak

Plant combination sample





Terraces
Khetbari



Plant combination sample



Sloping Agricultural Land Model

Alternating rows of permanent and non-permaent rows are planted on terraced land

1

- 1 Community center - community hall, classes, kitchen, storage
- 2 Chautari: Nepali rest stop archetype
- 3 *Fullbari Galli* / Orchard Alley - Row cropping agroforestry model



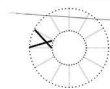
Mustard and oil
seeds
Watercress
Mango



June
Rice planting
festival

2

- 1 Public *Chautari*
- 2 Dispersed tree planting on terraces
- 3 Bird viewing pavillion + Shrine
- 4 Food forest/ Pakhabari
- 5 Border planting



Paddy
Tomatoes
October

Newari New Year

3

- 1 Non permanent crops
- 2 Mixed use tree rows on contour edge



Maize
Mustard and oil
seeds
Potato

**May
Machindranath
festival**

Discussion

6

Today, infrastructure projects are at the center of Nepal's national dialogue as the country seeks to move ahead to become a 'Naya' / Modern Nepal, seemingly breaking from its agricultural history. With little regard to landscapes and the communities that inhabit them, these infrastructures are poised to have massive consequences for urbanizing cities such as Kathmandu and their surrounding environment throughout the country.

Through research by designing, *Hariyo Mala* aims to project and share an alternative vision where infrastructure is productive, green, multifunctional, instead of extractive, grey and monofunctional. It imagines an urbanism that promotes and ethic of care for the environment and that values farmers, and communities that depend on them as stewards of the land and for all those that depend on it. The project explored how agriculture could be integrated into the urban fabric to envision more sustainable and resilient futures taking the Kathmandu Valley in Nepal as its context of study. The concepts of green infrastructure, and agroecology were explored to draw key principles and strategies, as well as key components that included typologies, assets, and practices. These synthesized strategies and components were then applied and tested through projective design explorations at various scales of intervention in the Kathmandu Valley.

The intersection of urban agriculture, green infrastructure, and agroecology is a promising area of research in designing for sustainable and resilient landscapes. Integrating principles of green infrastructure provides opportunities for reconceptualizing productive landscapes as an interlinked part of a network of other natural systems in the city and creates opportunity for urban agriculture to gain spatial significance in the urban fabric, thereby creating a new hybrid and productive infrastructure. Integrating principles of urban agroecology provides a pathway to transform how food is produced in the city through the incorporation of principles of ecology

and allows the reconnection of food production to its social meanings and movements.

Through this food is re:placed back at the heart of place making. Urban agriculture becomes urban agroecology, and green infrastructure becomes productive green infrastructure. Agriculture is celebrated not only for production of food but for all its biocultural diversity - to protect and enhance the environment, to nourish bodies and spirits, to connect and strengthen communities, and to cultivate a better future.

Future research could explore additional key sites along the selected transect on a site scale as has been explored in this project. This would support the exploration of vertical integration that has been initiated in this project and would provide more clarity on what horizontal integration would look like along the transect. These sites could include uphill settlements and community forests at the periphery of the valley to add another representative geography. Additionally, sites towards the city core, for example along the river, could also be promising to explore the potential of urban agriculture in more denser spaces of Kathmandu's fabric.

Moving forward, it also becomes important to consider the strategies that were synthesized and explored by the project in relation to development work that are being taken ahead by the state government of Nepal. This could prove useful in exploring tradeoffs and creating dialogue on how urban agriculture, green infrastructure, and food sovereignty should be considered as an important part of any development proposal moving ahead. Here, the matrix of components synthesized by this project could be utilized as a tool to initiate community engagement and incorporate more bottom up approaches to planning. Finally, the design explorations that the project has done is informed by the strategies derived and the set of components gathered from literature on green infrastructure, urban agriculture, and agroecology.

Future research could further clarify and illustrate specific steps that could be taken as a framework to further guide designers, planners, as well as stakeholders. Specifically, these steps could include those that connect planning approaches from green infrastructure and landscape ecology with those from agroecology. A key part of this framework should be an emphasis on community engagement and local stakeholder participation to inform the overall design and planning of the productive green infrastructure vision.

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