

Urban Metabolism As Integral Part Of Baguio City's Growth Node Development Plan

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ABSTRACT

The City of Baguio is now in the process of formulating development plans for six identified growth nodes which are the new centers of developments that aims to decentralize and decongest the city's main core and distribute major activities in other areas of the city. These nodes will also house buildings and other facilities that will support the intended function of each hub and will therefore be needing huge amounts of resources when it operates. With the mounting problems faced by the city due to rapid urbanization, the local government is seeking for ways to counter the adverse effects of these rapid developments. With the aim of achieving sustainable development for the new growth nodes, integrating the concept of Urban Metabolism (UM) into the plans, designs and policies that will implement and govern these future developments is seen likely to reduce the mounting problems being experienced by the city.

If adopted, these planning approach can be a model for other future developments not only for the City of Baguio but in nearby towns and cities as well. The integration of Urban Metabolism into the growth nodes will not only improve the quality of our urban environment but the quality of living for the residents including visitors. Thus, in this paper, case study on the concept of UM and the use of Urban Political Ecology (UPE) process of analyzing data is adopted in order to establish a benchmark for sustainable development strategies for the proposed growth nodes. Through UPE, the results derived from this paper through those data gathered and analyzed shall serve as a starting point for establishment of development guidelines and/or policies for Baguio City's growth nodes.

Keywords: Nodes, Growth Nodes, Urban Metabolism, Urban Political Ecology, Cyclical Economy, Urban Renewal, Renewable Energy

I. Introduction

In the context of urban design and planning, "nodes" are strategic foci or hubs and are usually found along intersection of paths or in concentrations, and may function as districts when a city is big enough for its level. Nodes can be represented in several forms and shapes and are often referred to as "cores" since most of these elements are where people converge and where activities are concentrated. Nodes may be seen in every picture of a city which can also be the main feature that defines the town or city (Watson et al 2003). On the other hand, "Urban Growth Centers" or "Growth Nodes" have a broader definition but are still classified as nodes and is connected to urban growth, referring to many forms of growth in an urban setting which includes population, land area, and intense land usage. It can also refer to unplanned urban development occurring on the outskirts of cities or an expansion in urban area, or an increase in the population residing in towns and cities (Burdett 2018). Thus, growth nodes, also known as growth hubs, are confined areas designated for densely packed mixed-use

development. To maintain this compact urban pattern distinct from others, smart growth planning principles are recommended (Vermont Department of Housing and Community Affairs 2007).

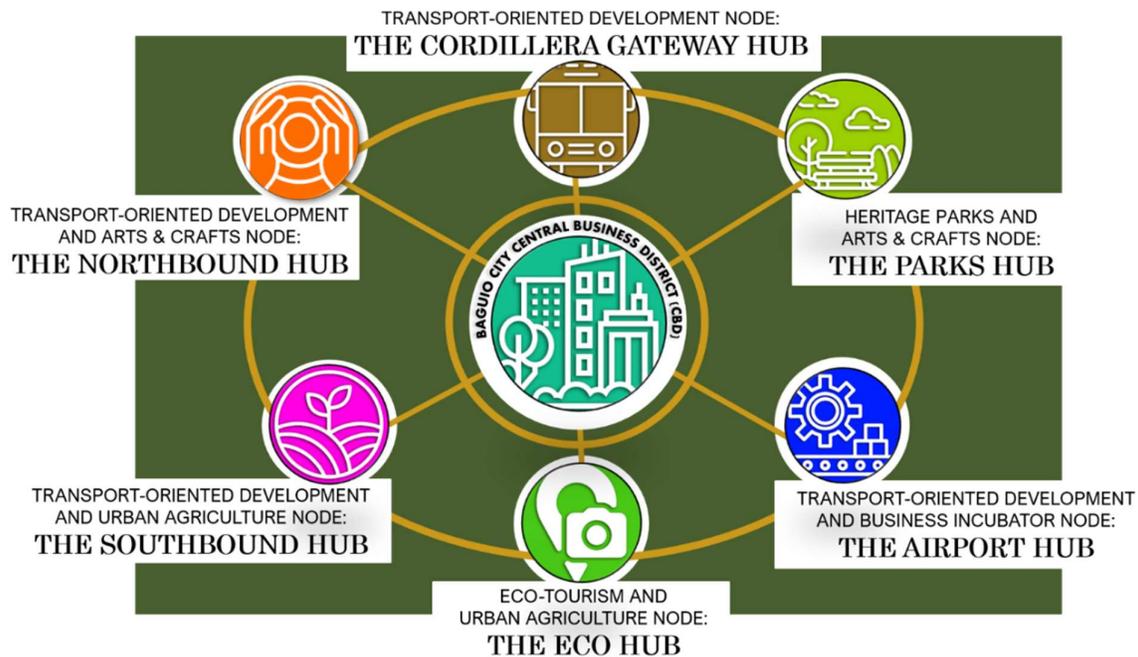
About 68% of world population will be moving to urban areas due to rapid growth of cities worldwide and that by 2050, this will lead to the high demand in resources as inputs to the urban system (Zanjani et al 2017). Though covering only about 2% of the planet's surface area, cities use about 78% of energy available to power materials and products like food, building supplies and energy resources which frequently result in environmental stress (Ulgiati and Zucaro, 2019), due to the high levels of human activity caused by rapid expansion of many cities. As a result, the question on how cities can mimic their natural ecosystem to meet their sustainable goals and what are their strategies to achieve it (Ham-mouda, Qadi, Salem, and Zanjani 2017)? Moreover, how can cities deal with the impacts of rapid urbanization which leads to the issues connected to urban sustainability, such as population pressure, resource constraints, and social inequity (Musangu et al, 2017)?

Asian cities on a global scale have served as hubs for both regional and global connectivity and for trade and commerce. Others develop for innovation, culture, and education, and are seen as important forces behind more robust and pertinent global economic contacts (Asian Development Bank [ADB], 2014). Urbanization occurs in many forms along with rising social inequality and increased environmental pressure, mostly are apparent in developing nations, where local sustainable development has emerged as a critical goal (Bancheva 2014).

Through in-depth studies, planners may learn about the various direct and indirect environmental effects of metropolitan areas' usage of natural resources by evaluating their metabolism to identify the best strategy that fits their development. However, creating regulations that support sustainable urbanization is not a simple task (ADB, 2014), and that the increase of human activity is essential to comprehending and modelling changes of Urban Metabolism (UM), as well as its relationship with societies and the mass energy flows that both shape and maintain it. Understanding urban metabolism within the framework of flow models is crucial as it integrates material fluxes through flow and circulation concepts (Dijst et al., 2018). By exploring UM approaches for Baguio City's Growth Node Development Plan, this paper aims to enhance the growth clusters, that the flow model concept of UM will serve as a framework for future growth hub design solutions.

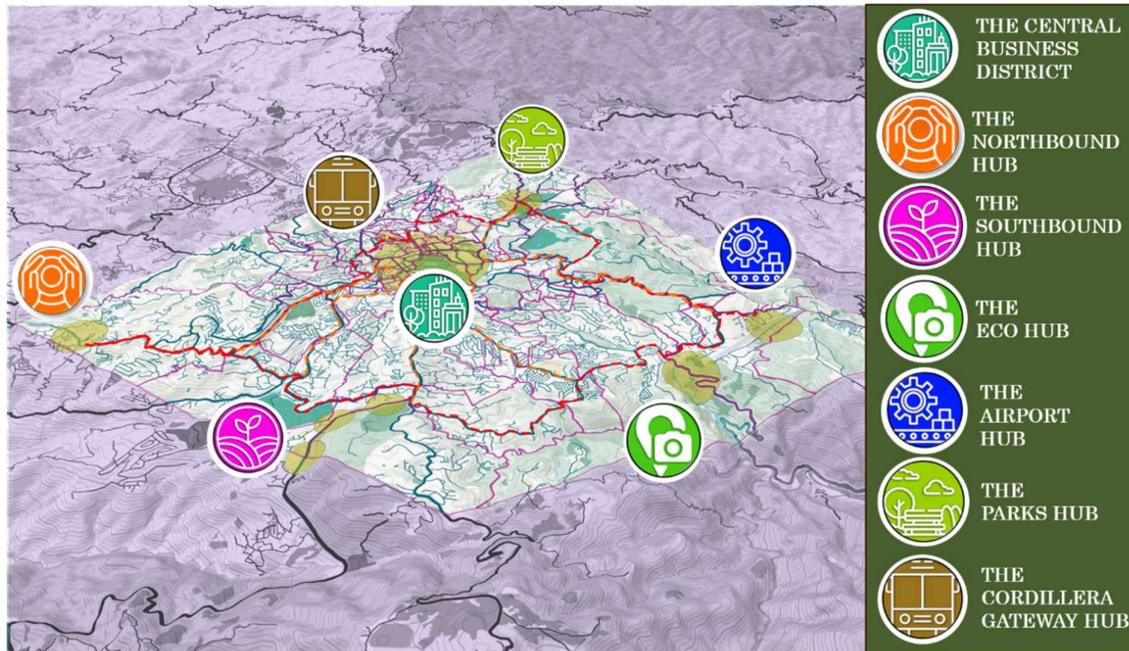
The Baguio Growth Node Development Plan

Figure 1.0 Baguio City's Growth Node development framework courtesy of City Planning, Development and Sustainability Office (CPDSO) (source: CPDSO).



The City of Baguio, through the City Planning, Development and Sustainability Office, (CPDSO) planned to create six new economic districts or "growth nodes," to relieve the congestion in places outside of the central business district (CBD), and minimize negative impacts of rapid urban development. The project's main goal is to make the CBD more bikeable, walkable, and green, but with specific deadline to its completion. Its main areas of interest are transportation development, urban agriculture, parks, cultural and landmark restoration, arts and crafts, ecotourism, and business incubation that includes the construction and management of the Loakan airport (Agoot, 2022).

Figure 1.1 Baguio City's Growth Node Development Plan courtesy of the CPDSO showing the different areas to be developed as new growth hubs (Source: CPDSO).



The nodes were identified separately and located along key strategic locations or zones (Figure 1.1) with each node playing a crucial part in Baguio's future growth, thus, requiring comprehensive master development plans. Led by Architect Donna Tabangin of the CPDSO, the stated masterplans would be incorporated into the city's comprehensive land use plan (CLUP) and serve as a template in the wholistic approach of development in City of Baguio. Redevelopments along Gov. Pack and Session Road, including the Public Market, will be implemented with the goal of improving pedestrian circulation areas with parking buildings while maintaining the CBD as the primary commercial and institutional hub (Samidan, 2022). The nodes are strategically linked by major roads with public transport, and planned as green to have low carbon solutions, focusing on tourist accommodations and transportation. The nodes may not be constrained by available power but the expansion of hi-tech industrial estates would place considerable strain in the system (Lindfield et al,2023).

Objectives:

In order to shed light in the concept of self-sustaining and energy efficient growth nodes, this paper aims to unravel the different strategies of urban metabolism through urban design:

- a. Evaluate Baguio City's material flow in order to establish a common benchmark for the sustainable strategies of the project.
- b. Identify the best practice or model of Urban Metabolism that will generally fit into the proposed growth nodes.
- c. Establish a development framework that will integrate Urban Metabolism for Baguio City's proposed growth nodes.

II. Materials and Methods

With the aim of establishing a benchmark for integrating sustainable urbanization into Baguio City’s Growth Node Development Plan, this study seeks to ensure that the local government will shift towards a more sustainable production and consumption patterns for its future developments through UM. Since this study is purely on the conceptual stage, it will adopt an observational and descriptive research approach where the review of literature is drawn from scientific journals, government data and reports, news articles and other related studies on UM, including those data prepared by the CPDSO. A case study is to be conducted where textual analysis approach is to be employed in the chosen field of study to assess the effectiveness of the different sustainable development strategies, and develop a framework or model to fit the proposed growth nodes.

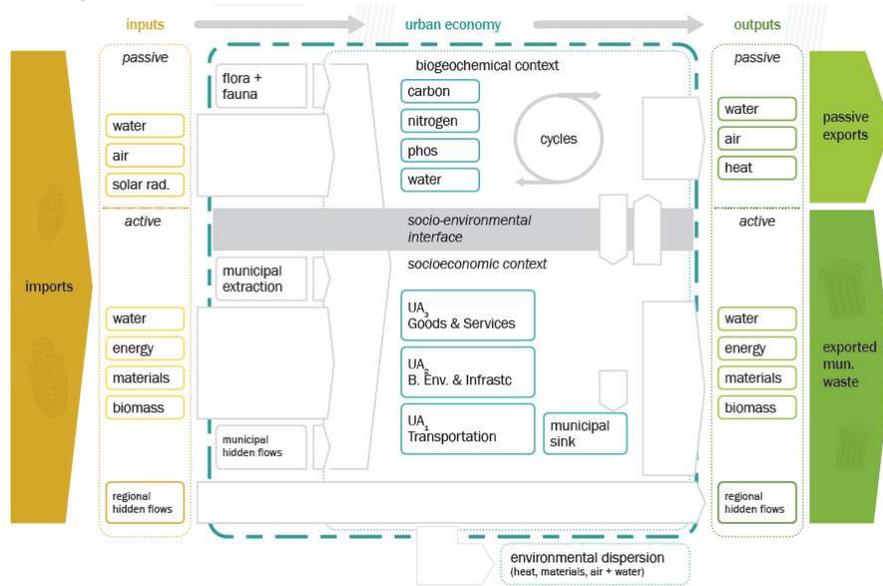
For a better grasp of the analysis of collected data, Urban Political Ecology (UPE) shall be utilized in the process as it focuses on decisions of urban development and aims to understand how our urban elements evolve and regenerate (Tzaninis et al 2020). Cousins and Newel (2019) further suggest that UPE is to be employed as a means to clarify the analytical focus and purposes, setting an emphasis on the individual and comparative case studies focusing on the politics of urban nature occurring within cities. A large portion of the UPE by literature has treated the study of a city as a specific socio-natural artifact that is fashioned through metabolization of nature. For UPE to increase understanding of urban ecological change, the UPE study and methodology are essential for creating exemplars, thus an analysis of existing practice of UM through case study would be suitable for this study.

III. Literature Review

The Urban Metabolism Concept

The concept of Urban Metabolism (UM) has gained widespread usage across multiple disciplines and was utilized to examine the interplay between the elements of the urban environment and its connection to the surrounding hinterlands (Bancheva, 2014). The concept of UM has resurfaced after a long period of silence and although its founders have varying interpretations, each is influenced by their field of expertise. Despite these differences, UM is generally understood as the city’s process of acquiring resources from its environment, using them for economic outputs and social services, and subsequently releasing waste back into the environment. UM can then be understood as the course through which a city attains its resources from its surrounding environment and use them for economic processes and services and releases its waste outputs back into the environment (Musango et al, 2017).

Figure 3.0 The Urban Metabolism Framework by the United Nations Environment Programme (Musango et al, 2017).



Part of the growth nodes development plan is the integration of the smart city concept, which is the enhancement of waste reduction efficiency by providing real-time information on resource consumption, enabling resource application and identification of flaws. This includes gas, electricity, and factory materials. Smart homes, with data-driven technologies, enable smartphone control of fundamental home functions (Salat, 2021). Smart technologies will therefore play an important role as it helps in the real time monitoring of consumption of resources and waste management. As shown in Figure 3.0, Musango et al (2017) urban metabolism framework assessment outlines the connections between resources, urban bio-social processes, and urban activities like housing, goods, and services, including logistics of people and goods.

Bancheva (2014) further discussed that UM aims to create a circular economy by transforming solid waste into energy sources and recycling processes, promoting self-sustaining developments, where excess energy produced can be shared with neighboring communities or other government facilities, enhancing waste management and energy consumption. This study aims to develop a framework for planning the growth nodes by capturing the dynamic flows of products and materials in uneven-ecological systems with urban political ecology (UPE) as a data processing tool, providing planners and designers with a clearer understanding of resource, capital, and commodity movement in cities (Cousins and Newel, 2019).

Case Study: Stockholm, Sweden: The Waste-to-Energy Programme in HammarbySjöstad

Figure 3.1 The *HammarbySjöstad's* unique and green Urban environment. Retrieved <https://ecodistricts.org/wp-content/uploads/2016/09/hammarby-feature.jpg>



Stockholm (Sweden), has had a development akin to other European towns whose economies flourished on a global scale. Policies and initiatives aimed at increasing the city's competitive advantage and attracting foreign investment through the enhancement of infrastructure across multiple sectors have contributed to the expansion of this city. With its physical and economic expansion, the city now faces growing problems like gentrification, poverty, and spatial segregation, though they are relatively modest in their present situation, these problems are shared by all growing cities (Bancheva 2014). However, Stockholm was already at the vanguard of eco-neighborhood advancement when it refurbished the southeast neighborhood of HammarbySjöstad as part of its quest to host the 2004 Olympics, prior to the city's foray into sustainable development through *urban metabolism*. HammarbySjöstad's redevelopment goal was to build a neighborhood that combined a human scale design with low-carbon transportation, ecology, and sustainable resource usage, all while having half the environmental effect of other 1990s districts (Salat 2021).

Hammarby's Urban Metabolism Model

Hammarby's UM model extracts resources from waste streams for generating energy and recovering heat which also helps in the elimination of the concept of waste, where energy is captured from three waste flows. The total energy extracted from waste is estimated at 31.3kWh/m²/y where 25.5kWh/m²/y for heating and 5.9kWh/m²/y for electricity (Salat 2021). The three waste flows where energy is extracted are:

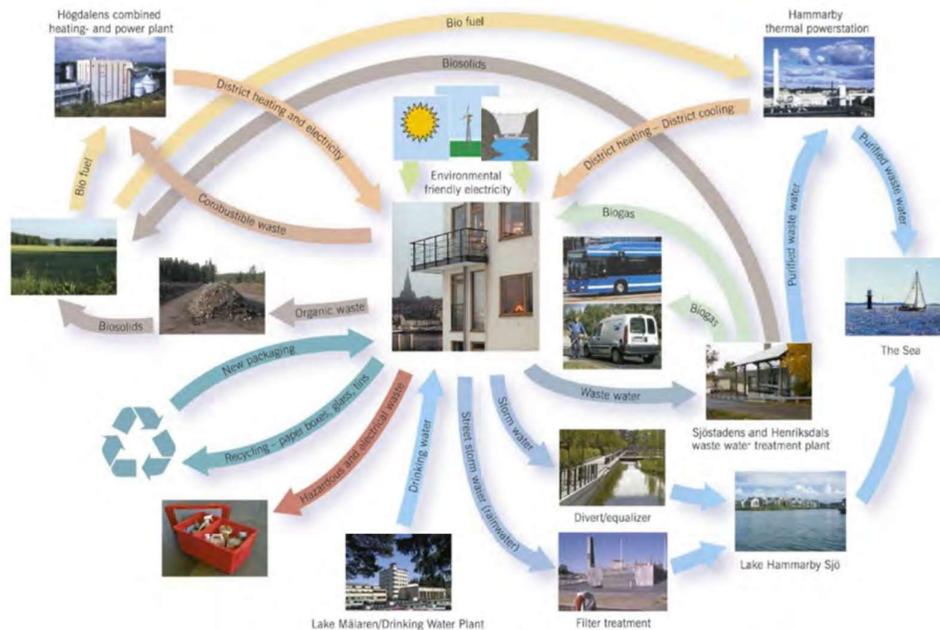
1. Burns of combustible garbage to power a local district heating and electric cogeneration plant.
2. The recovery of heat from sewage treatment plants.

3. Conversion of sludge to biogas for cooking (1000 units) and to power local buses.

But before achieving the amount of extracted energy from these processes, the first step is to diminish the initial flow of waste. HammarbySjöstad has set the goal of reducing solid waste by 15% by weight and further has taken the most comprehensive approach by reclaiming all the remaining flows (Salat 2021). The following are the actions taken:

- Their use of recycled materials where it is more environmentally and economically feasible
- Deposit no more than 20% of construction waste and landfills.
- The sorting and gathering of all solid waste which includes glass, plastics, metals, and paper, using a vacuum system at locations around the site, and then recycle it.
- The scheme eradicates the energy required for transportation and pollution caused by garbage trucks.
- The collection of combustible waste and transforming it into district heating and electricity.
- The collection and composting of organic waste which can also be used for fertilizing plants which can also help to the reduction of biowaste.

Figure 3.1 The **HammarbySjöstad** Urban Metabolism Model (Salat 2021).



IV. Results and Discussions

Baguio’s Proposed Growth Nodes

Samidan (2022) has enumerated the six identified growth nodes and their functions are listed as follows:

1. The Southbound Hub – is planned to be a transport-oriented community and urban agricultural hub that is situated in Dontogan under a usufruct agreement with the Department of Agriculture.
2. The Northbound Hub - a transport-oriented development situated in Barangay Irisan is to include a node to house arts and crafts.
3. The Cordillera Gateway Hub at Sto. Niño Barangay is planned to have commercial spaces and cold storage facilities aside from the much-needed terminal and parking building.
4. Mines View Barangay shall contain the Parks Hub which will undergo modifications with additional attractions and extra riding routes at Wright Park.
5. The Eco Hub Zone at Kennon Road, which shall be focused on eco-tourism and agriculture with a view deck and terminal parking.
6. The Airport Hub - is envisioned to be a transport-oriented and business incubator zone located along Loakan area.

Baguio’s present Urban Metabolism

Solid Waste Management Data

Over the years, the city government of Baguio has switched to dump their solid waste to Metro Clark waste management site in Tarlac after its local dump site has collapsed in 2011 (Chepelianskaia 2023). To reduce the amount of solid waste produced by the city, every household are already obliged to segregate their garbage by dispose their biodegradables through composting and other alternatives. Then the remaining waste are hauled to engineered sanitary landfills outside of the city while the local government is on the process of planning in establishing a waste-to-energy plant (See 2019).

Figure 4.0 image showing the collection of solid waste by the Solid Waste Management of the City of Baguio (Chepelianskaia 2023).



Table 1.0: The calculation of solid waste generated vs the solid waste sent to the landfill arranged by category (Chepelianskaia 2023).

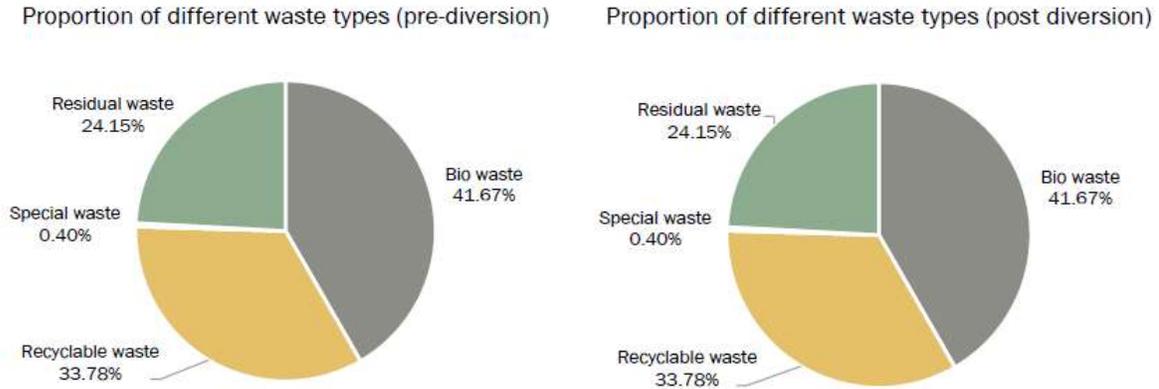
Type	Percentage of total	Kg	Diversion rate (%)	Kg disposed (after waste diversion)*
Biodegradable	41.67	177.38	23.24	136.16
Recyclable	33.78	143.79	23.24	110.38
Residual waste	24.15	102.80	0	102.80
Special Waste	0.40	1.70	0	1.70
Total	100.00	425.67		351.03

*per capita per year.

At present, volunteer and regular garbage collectors of the General Services Offices (GSO) who manage Baguio’s solid waste have already been sorting out recyclable and reusable waste including some toxic waste before being hauled to the sanitary landfills. The segregation and diversion of recyclables and reusables has a significant impact to the waste generated per capita per year in the city. Based on the research conducted by Lunag et al (2019) on the Waste Analysis and Characteristics Study of Baguio City, the report shows that the waste generated by the city comprises of biodegradables (41.67%), recyclables (33.78%), residuals (24.15%), and

special waste (0.40%). Chepelianskaia (2023) has also further reported in Figure 4.0 the latest data of the composition of solid waste of the city of Baguio before and after diversion.

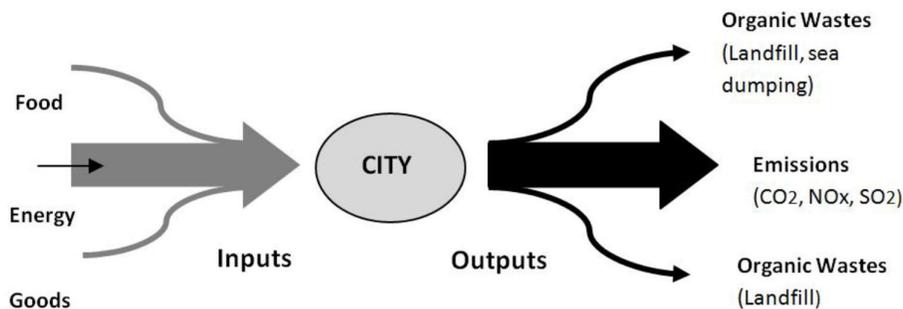
Figure 4.1 The ratio of various types of waste collected before (left) and after (right) diversion to the landfill (Chepelianskaia 2023).



Looking at the numbers shown in Table 1.0, there is a significant reduction of solid waste equivalent to 74.64 kg per capita per year equivalent to 17.53% after the diversion of some recyclable and reusable waste before its disposal. This data shows that the city of Baguio’s material flow is in linear metabolism where majority of the waste products of the city are not fully optimized before being transported to the landfills. And just like other contemporary cities, most of their materials and energy flows are high and through (Kennedy et al 2010). Delivandani et al (2021) further mentioned that, linear metabolism puts pressure on the remaining local resources increasing the adverse impact on the natural environment during its extraction and the disposal of its wastes. This is reflected on the current water problem faced by the City of Baguiowhere the growing water requirements coupled with it dwindling forest cover has outstripped its water resources causing shortages of supply (Gonzales 2016).

Aside from solid waste, the problem on waste water in the City of Baguio is a growing concern as the present liquid waste infrastructure of the city is insufficient and outdated and that waste water are mostly released into the bodies of water without treatment. This is due to the fact that there is only a single sewage treatment plant, the Balili Sewage Treatment Plant (BSTP) that services and process the city’s wastewater, where there are only about 50 Barangays that fully connected and another 15 that are partially connected to the BSTP. This leads to the increase of greenhouse gas emissions (GHG) thus requiring the city to invest on sewage treatment plant with an increased capacity to reduce the impacts of liquid waste (Chepelianskaia 2023). Hence, the present condition of Baguio’s solid waste and wastewater management reflects a linear form of metabolism (Figure 4.2) where the flow of materials and other resources are not fully optimized from production to consumption.

Figure 4.2 The Typical Linear Metabolism Model of Cities (Bancheva 2014) which is most likely the same model that illustrate Baguio’s material flow.

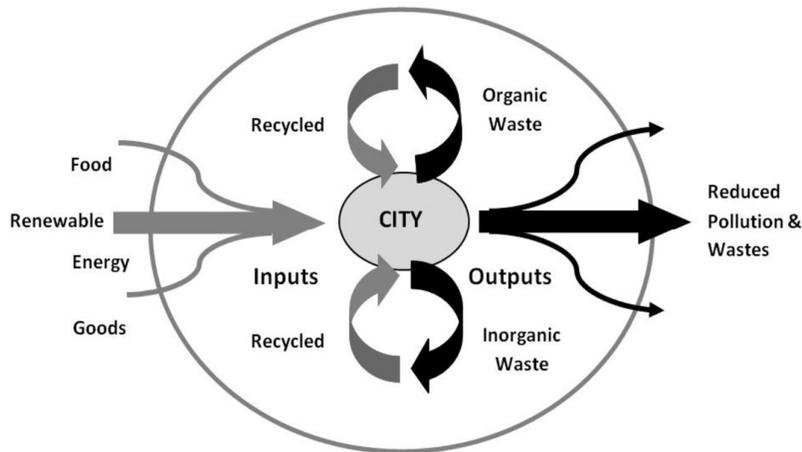


Application of Urban Metabolism in Baguio’s Growth Nodes

The high amounts of consumed resources and coupled with waste generated by cities are the problems that requires great attention and that the rise of approaches in circular economy and concepts of UM reveals the urgency of the issue (Longato et al 2019). Stockholm's UM model is a good example of effective management in the application of cohesive sustainable approaches specifically those in **HammarbySjöstad. Their adaptation of sustainable development practices has also enhanced their economic and social benefits in many parts of their city** (Bancheva, 2014). And in an urban ecology, it is wise that planners understand the link between material and energy flows with ecological and social processes which will improve the flow model of a city into a more sustainable consumption and production pattern (Dijst et al, 2023). The concept of UM is therefore vital in the development of growth nodes and that beyond the study of UM, there are practical applications with scientific approaches which includes policy analysis and urban design (Kennedy et al 2010).

In the case of Baguio City, several options have already been considered by the local government but requires further study. In a report by Duran et al (2020), there are several alternatives available and some being practiced for the reduction of solid waste produced in the city. Many of these alternatives adapts the process of allowing bio-waste to undergo the natural and human controlled processes to turn waste to animal feeds, others into fertilizers and the rest to safely decompose and be back to the natural environment. The study further concludes that bio-waste can be cut down significantly to approximately 64% if facilities will be working in full capacity. For other waste forms, Refuse Derived Fuel (RDF) is another solution which provides the reduction of solid waste through unregulated-burning for waste-to-energy potentials from residual waste (Duran et al, 2023). These alternatives can also play a vital role in resolving some of the energy issues being faced by the city at present.

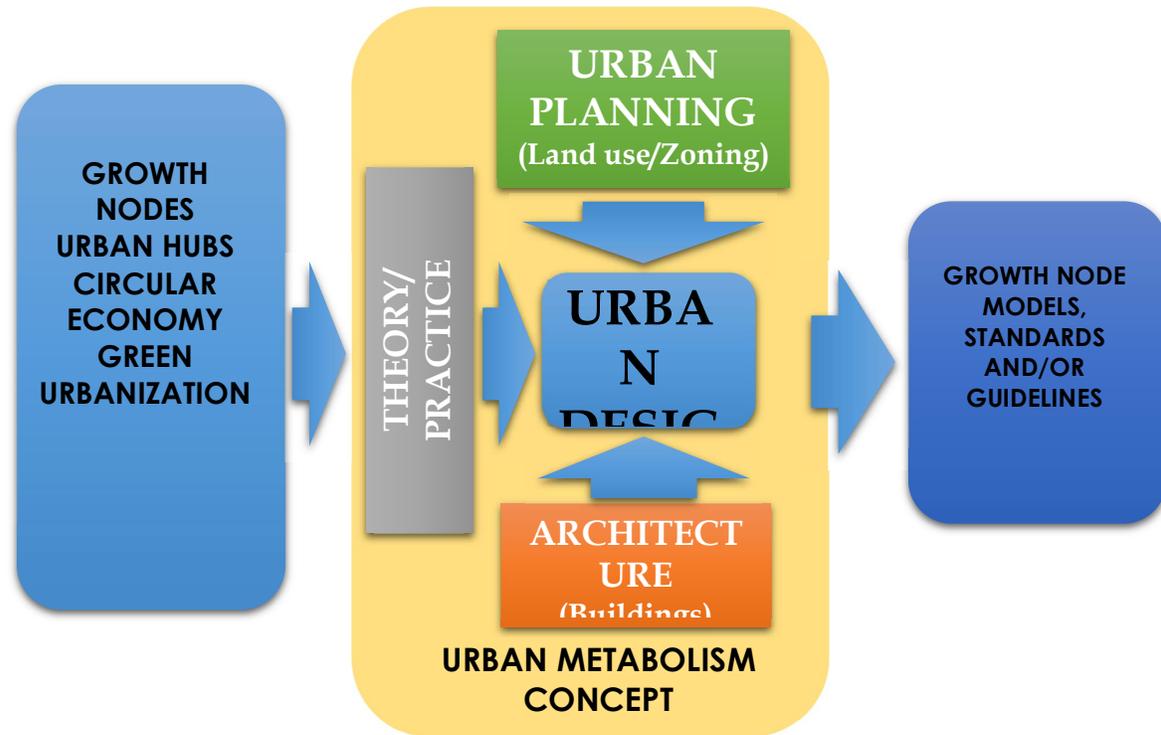
Figure 4.3 Circular Metabolism Model of Cities (Bancheva 2014).



On the part of wastewater, various solutions have also been considered by the city to address the growing issues on liquid waste. In an article by Jocson, L.M.J. (2023), she stated that Japan is introducing decentralized wastewater treatment system for Baguio City through the Japan International Cooperation Agency (JICA). The project aims to bring in the expertise and innovation of the Japanese in terms of wastewater management which can be adopted by the public. The technology that the Japanese would bring in will be a great contribution to the creation of plans integrating the concepts and principles of UM into Baguio's Growth Nodes. The introduction of decentralized wastewater treatment facilities will help increase the capacity of the city to collect and treat wastewater and help reduce the impact of liquid waste to the city's existing bodies of water.

Urban Metabolism Framework for Baguio City's Growth Nodes

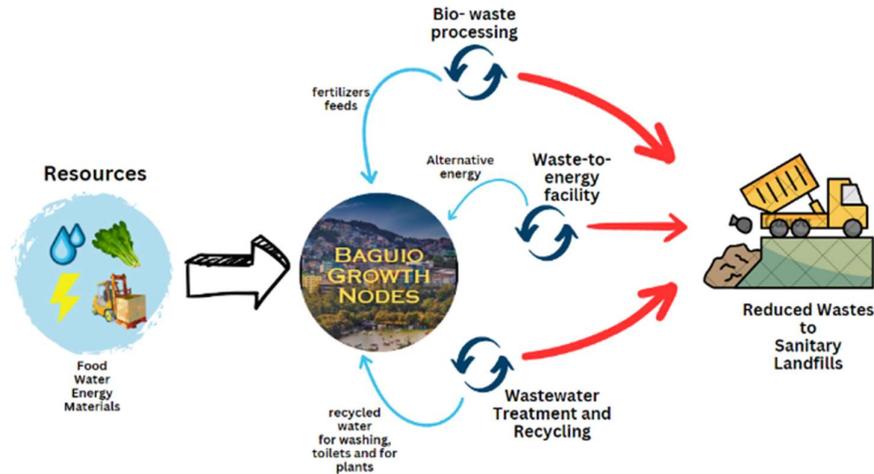
Figure 4.4 The Urban Metabolism framework for Baguio City's Growth Node Development Plan (by Author).



This paper focuses on integrating UM into the Growth Nodes to meet its current and future needs where each node having functions based on the pre-determined economic activities by the local government through the CPDSO, based from data gathered from various agencies. Recovering from the global pandemic, the city faces growing problems due to rapid urbanization, highlighting the need for sustainable solutions. Baguio, just like other cities, is vulnerable to natural disasters and climate change due to the growth of impermeable paved areas. This increases susceptibility to landslides and floods, caused by siltation, stream narrowing, natural and artificial drainage obstructions, and inadequate drainage systems' capacity (PreventionWeb 2021). Sustainable development solutions through concepts of UM is seen to have a great contribution to reduce the impacts of disasters to the quality of life of the people.

Apart from the impact of disasters to the city's development, the concept of UM is seen to help reduce the city's problems with solid waste as well as other types of waste produced, and incorporating UM into the city's growth nodes program will be a positive development for its waste-to-energy program. As shown in Figure 4.5, with UM applied to Baguio's Growth Node Development Plan, the concept is seen to reduce the amount of waste generated by the city which in the end will also create a circular economy within the new nodes.

Figure 4.5 The Circular Metabolism for Baguio City’s Growth Nodes (Source: Author)



Challenges of Urban Metabolism for Baguio’s Growth Nodes

Stockholm’s model of UM is a good example of leadership in sustainability, yet there are several challenges that needs to be addressed. However, Bancheva (2014) claimed that Stockholm’s approach to sustainable urban development can be useful example which can be adopted by other cities in developed countries, but its application to low-income nations has no certainty. Just like other developments around the world, urban systems and cities are complex entities that have their own metabolism which are extremely demanding for various materials and energy within and around their boundaries (Ulgiati and Zucaro, 2019). However, in a report by Duran et al (2020), they mentioned that the city of Baguio has the capability of cutting down the amount of solid waste hauled to the sanitary landfills outside of the city.

Duran et al (2023) also stated that waste-to-energy plants which is promising for urban cities such as Baguio, is hindered by environmental, social and economic factors specially that incineration is still not permitted by Philippine Clean Air Act or RA 8649. It is therefore important that emissions are properly mitigated with proper pollution control devices for the waste-to-energy facilities to be safe and acceptable to the public. Moreover, Yang and Nordhaus (2006) reported that the transfer of environmentally sound technologies particularly for GHG mitigation is complex due to the methods and practices not compatible to the new technologies introduced (as cited by Duran et al 2020). Moreover, the movement of people also contributes to the increasing problems of cities as it surges the demand for resources, increasing the production of waste which can also contribute to the effects of climate change (Ulgiati and Zucaro, 2019).

V. Conclusion

UM is concept of urban design and urban planning that creates a model of urban development that integrates material and energy flows and its processes in a manner to optimize their use and increase the level efficiency of a city, district or node’s operation. Despite the various approaches being practiced in UM, it has a strong focus on sustainable development and with the aid of system feedbacks which makes it a useful tool not only in planning urban areas but also a great help in the decision-making process for those who carry out the development, operation and management of urban areas. Local policy makers therefore play an important role in the crafting of laws and ordinances that will help in the implementation and management of the urban ecosystem and transform the current linear flow of resources into and outside the city to create a circular and more sustainable flow that is more mature form of urban ecosystem.

With UM applied into Baguio’s new growth nodes it will not only reduce the city’s problem on waste but energy consumption as well, slowing down the process of entropic decay of material and energy without affecting the quality of life of the people. It is therefore important that addressing spatial distribution in the planning process and the strict and efficient management of urban resources is vital into the integration of UM into the growth nodes.

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