Analyzing the Resource Flows in Sorsogon City Using the Urban Metabolism Framework

Gremil Alessandro Naz[1], Virgil Bello Bilaro[2], Erwin Espiritu Torres[2], Richard Laus Bartolata[2], Davie Bongalonta Balmadrid[2], Shiela Benitez Desuyo[2], Ricardo Madrid Belgica[2], Susan Salvador Janer[2], Ritzelda Agnes Deri[2], and Franklin Mandane Miranda[2]

[1]Bicol University
[2]Affiliation not available

May 13, 2019

Abstract

This study examined the flow of selected resources in Sorsogon City using the urban metabolism approach. The resources analyzed were water, energy, food, and construction materials. These were chosen using a toolkit provided by the United Nations Environment (formerly the United Nations Environment Programme), which funded the study. Primary data were gathered through key informant interviews and a focus group discussion with individuals knowledgeable on the four resources studied. Secondary data were obtained from the Sorsogon City Hall, other government offices, and private organizations. The documents and the responses of the study participants were used in the analysis. Findings showed that the Sorsogon City Water District's production volume for the next 10 years is sufficient to meet the needs of the growing population. However, this does not consider the areas not serviced by the water utility—which is half of all the barangays in the city. Meanwhile, if the present population growth and energy utilization rate remains the same, Sorsogon City will need to increase its electricity and liquid fuel imports. This is because all power used in the city is imported. Similarly, if Sorsogon City does not adopt any changes in its rice production scheme (i.e., no change in annual yield and production area), it will need to increase imports to supply the growing demand. Likewise, since the city has no local source of construction materials, it will continue to be a net importer of steel, cement, sand, and aggregates. Based on these results, several recommendations were made by the researchers for the consideration of Sorsogon City officials.

Introduction

According to Dodman, Diep, and Colenbrander , cities accounted for 54 percent of the total global population in 2014. However, even if only a little over half of humanity lives in urban areas, up to three quarters of the world's natural resources are consumed there. Due to the large number of people living in these places, they are more prone to environmental hazards. Worse, these vulnerabilities are exacerbated by climate change and a growing population.

Cities are the centers of economic activity, accounting for over 80 percent of global gross domestic product, said a United Nations (UN) report . Thus, they require huge amounts of natural resources that are not all available within their boundaries. This forces them to import resources, which makes urban areas' social and ecological impact spill over even to rural regions.

The same report noted that cities are "hotspots of vulnerability" that makes them exposed and susceptible to environmental risks. In addition, resource scarcity is a constant threat.

Hence, there is a need for proper spatial planning, solid waste management, and building standards. However, policies for such undertakings need to be in place. These rules and regulations can only be correctly enacted

if policymakers are guided by sufficient data.

Study Framework

One helpful intervention is the Global Initiative for Resource Efficient Cities (GIREC), a cooperation platform offered by the UN Environment Programme (UN Environment). The GIREC, using the urban metabolism approach, has created a toolkit that aims to take stock of a cities resources. Once a city is aware of its resource flows, it is equipped with the knowledge to enact proper policies to make itself more sustainable.

As a network platform, it "provides a mechanism for decision makers to exchange experiences, share best practices, and establish a peer-review process across cities for further improving access to resources and their efficient use" . In fact, it has already organized gatherings of city mayors and experts to exchange ideas on the efficient use of natural resources.

To put GIREC's ideas into practice, the urban metabolism approach has been piloted in six cities worldwide. This was done using the toolkit that aims to collect data on water, energy, waste, food, construction materials, and land use. The collected information and the subsequent input-output analysis are expected to help local officials craft appropriate policies for their city.

Methodology

Initially, the project team gathered secondary data from Sorsogon City Hall and other relevant offices. The researchers went to the mayor's office and were endorsed to the heads of the various departments. Letters requesting for access to data from non-city hall offices were signed by the mayor to help the team obtain information from the public utilities and national government offices. Since the study involved human subjects, approval was sought from the UN Environment and Bicol University.

It is necessary to state how important the assistance of the city is to this endeavor. Without its help, it would have been impossible to secure data and interview key informants. This level of cooperation was also praised by Mias-Mamonong and Flores in their vulnerability assessment of Sorsogon City.

To gather information not available in official documents, key informant interviews were conducted among city hall department heads, as well as with representatives from the public utilities and national government offices. The interviewees went to the city hall upon the invitation of the mayor, which ensured their cooperation.

A focus group discussion was held with the heads of barangays not served by the Sorsogon City Water District (SCWD). It was discovered during the examination of the secondary data that only half of the city's barangays were serviced by the SCWD. Thus, the documents from the water district were not enough to provide a complete picture of the water access in the city. It became necessary to talk to the heads of the unserved barangays.

To analyze the data, the researchers used a simplified version of Barles's method—which is based on the determination of the main inputs and outputs of the system under consideration. It does not require a description of the material circulation within the system, so it is fairly easy to perform (see Table 1). The inputs should be equal to the sum of the utilization and outputs.

Table 1. The input-output table used in the analysis

Inputs	**Utilization**	**Outputs**
Local extraction Imports	Material throughput Recycling	To nature (local) To nature (exported)

Results

Except for energy, Sorsogon City imports more than it exports (see Table 2). By import and export, we mean the resources that go in and out of the city boundaries respectively. Thus, materials coming from as

near as the neighboring towns and as far away as outside the Philippines are all considered imports.

Table 2. Input-output table of water, energy, food, and construction materials in Sorsogon City11An input-output table must be balanced. Meaning, the input should be equal to the sum of the utilization and output. However, this is not the case in this table because the amount of water and food input is the same as both the utilization and output. But if we remove that amount from the output, the table becomes balanced. Thus, input = utilization + output – water and food waste = 67,437.97 kilotons/year

Input
Local extraction Water: 66,296.84 kilotons/year Power generation: 1,017.48 kilotons/year Agricultural production: 21.41 ki 67,437.98 kilotons/year

Water in most of Sorsogon City is provided by the SCWD, accounting for 62 percent of water extracted in the city. The remaining 38 percent is distributed by Barangay Water and Sanitation Associations (BAWASAs), or village-level organizations that provide water to residents. All these sources account for 4,589.21 kilotons of water extraction per year. After utilization, these become wastewater—but with only 36.99 kilotons going through treatment. Meanwhile, the volume of irrigation water is 61,693.13 kilotons. These are not provided by the SCWD and BAWASAs but are diverted by the national government from various sources.

In terms of rice, the staple food in Sorsogon City, 19.82 kilotons are locally produced while 9.02 kilotons are imported. However, the city exports the relatively small amount of 2.16 kilotons during the harvest season.

Meanwhile, officially, all construction materials are imported except for coco lumber. We say "officially" because this is what the City Engineering Office (CEO) has told us. Unofficially, there is local extraction of lumber and aggregates. This is done illegally, so no data are available on extraction volume. The best that the team could do was provide an estimate: 7.39 kilotons of sand and 10.95 kilotons of aggregates. These figures were derived using simple linear regression, with the length of road as the dependent variable and time representing years 2005 to 2008 as the independent variable. Results showed a coefficient of determination of 0.77, which is relatively high, and a slope coefficient of 8.24 kilometers per year. This is the average increase in the length of concrete road per year in the province of Sorsogon.11The available data from the Philippine Statistics Authority were at the provincial level. The city-level figures we present in the next sentences are estimates. If Sorsogon City accounts for 20.52 percent of the national road in the province and if we assume that the annual increase in road length is equal among its municipalities, then the length of road constructed in the city increases by an average of 1.71 kilometers per year. For this road length, the volume is approximately 2,400.59 cubic meters if it has a thickness of 0.23 meter and width of 6.1 meters. If sand has a density of 1.54 tons per cubic meter, aggregates have density of 1.52 tons per cubic meter, and a very strong concrete grade with a cement-sand-aggregate ratio of 1:2:3 is used, then the 1.71-kilometer stretch of concrete road needs 7.39 kilotons of sand and 10.95 kilotons of aggregates.

Every year, approximately 17.78 kilotons of sand, 19.04 kilotons of aggregates, 12.62 kilotons of cement, and 2.92 kilotons of steel are imported by the city. There are no exports of construction materials.

While the inputs are greater than the outputs for water, rice, and construction materials, the situation is opposite for energy. It exports 978.68 kilotons of oil equivalent (KTOE) of geothermal power and 0.45 KTOE of hydropower annually. Unfortunately, the city cannot use this clean energy because the present electricity distribution system in the Philippines requires all power producers in Luzon to export to the grid. Thus, cities that have power plants cannot directly use the electricity produced within their boundaries. Because of this, Sorsogon City—through power distribution utility SORECO II—imports 4.14 KTOE of electricity from the Luzon grid every year. In addition, the city buys 7.08 KTOE of liquid fuels annually.

All the data used for analysis, and their sources, are presented in Table 3.

Discussion

Sorsogon City is a net importer of resources. Except for coco lumber and illegally obtained local materials, all construction items are imported. Its local rice production cannot support the population, so there is a need to import. Although the SCWD claims that there is enough water for the next decade, this is only true for its concession area; that conclusion cannot be carried over to the non-SCWD areas. Finally, even if the city exports a big amount of geothermal energy, the electricity and liquid fuels it consumes are all imported.

Table 3. Data used in this study and their sources

Data	**Source**
2015 census of population	Philippine Statistics Authority (PSA)
Amount and percentages of water extraction in Sorsogon City	SCWD
Amount of construction materials illegally extracted in Sorsogon City	Interview with knowledgeable individuals
Amount of construction materials imported by Sorsogon City	CEO
Amount of geothermal power extracted in Sorsogon City	Energy Development Corporation
Amount of hydropower extracted in Sorsogon City	SORECO II
Amount of liquid fuels imported by Sorsogon City	Interview with sellers
Annual per capita consumption for Sorsogon province (2012)	PSA
Auxiliary invoice for various fisheries products	City Agricultural Services Office (CASO)
Data on land use in Sorsogon City	City Planning and Development Office (CPDO)
Data on wastewater from the public market and slaughterhouse	City Environment and Natural Resources Office (C
Disaggregated number of electric connections in Sorsogon City	SORECO II
Electricity consumption and losses in Sorsogon City	SORECO II
Irrigation data	National Irrigation Administration (NIA)
Length of roads by type	PSA
List of ordinances and resolutions	City Records Department
Projected water production in Sorsogon City	SCWD
Proportion of cement, sand, and gravel for road construction	Department of Public Works and Highways
Solid waste data and Integrated Solid Waste Management Plan	CENRO
Sorsogon City agricultural profile	CASO
Sorsogon City fisheries profile	CASO
Sources of water in Sorsogon City	SCWD
Water usage and losses in Sorsogon City	SCWD

Thus, it is obvious that Sorsogon City is not self-sufficient. Granted that it cannot use its geothermal energy due to the grid system in Luzon and it does not have mines that can provide most construction materials, the city can still do something to make resource use more efficient.

Fortunately, Sorsogon City is on the right track. It has policies that mandate environmental sustainability. One example is the Organic Agriculture Ordinance of 2010. As an agricultural intervention, it aims to solve the city's food problems. The use of natural fertilizers and pesticides reduces the dependence on synthetic chemicals, which pollutes bodies of water. This will lead to the preservation of water sources.

The said ordinance ties in perfectly with the Local Drinking Water Quality Monitoring Code of 2015. If water sources are free of contaminants, then they are safe for drinking as mandated by the code. This ordinance also has implications for water utilization. Many BAWASAs may not have enough resources and expertise to ensure that their water is potable. Thus, many barangays will have no choice but to connect to the SCWD, which follows stringent national laws on water quality. This is good in terms of efficiency because the 50-percent systems loss of the BAWASAs are very high compared to the SCWD's 26 percent.

However, city leaders should expect some resistance because there are BAWASAs that do not charge for the water they supply. It is natural for people to resist paying for something they used to get for free. Still, decisionmakers should have the political will to see this through. As long as residents are getting water for

free, most will not try to conserve.The Ecological Solid Waste Management Ordinance of 2005 mandates a sustainable solid waste management system, which aims to reduce the waste in Sorsogon City. Those that can be reused or recycled are segregated so that they can be made useful again, thereby reducing imports. In addition, if these are removed from the waste stream, the chances of soil and water contamination are lessened. Thus, lands can become more productive and clean water sources are maintained. Likewise, the ESWM ordinance will serve as the basis for the city to establish a sanitary landfill and materials recovery facilities. This will improve the practice of reusing and recycling, as well as stop the harmful practice of open burning.

As Sorsogon City slowly urbanizes, it has started to feel the effects of urbanization. There have been positive consequences like more infrastructure, economic progress, increase in the number of available jobs, and growth of the business sector.However, it cannot be denied that urbanization also has negative effects. These are heavy traffic, conversion of agricultural lands, sanitation problems, and environmental degradation.

In sum, the result of the urban metabolism analysis clearly supports the continued implementation and strengthening of these ordinances. These are rational policies supported by available data.

Conclusions and Recommendations

When we say that Sorsogon City is a net importer of resources, it does not mean that the situation is bad. For all we know, it is more efficient for the city to import rather than produce. Example, should Sorsogon City aim to increase rice production, or should it rely on importation to augment supply?

This is a question that only the city leadership can answer. It is always good to be self-sufficient, but what if increasing production means expanding rice fields? This will eat into other lands, like public open spaces—which Sorsogon City sorely lacks.

Meanwhile, importing rice will not affect the city's present land use. The downside, though, is that Sorsogon City will be at the mercy of the exporting municipalities. In times of draughts, these exporters will—of course—take care of themselves first rather than export rice.

Thus, in terms of policy, the city must choose between two options. First, increase production by converting other lands to rice fields. Second, continue importing but making sure there is a buffer stock so that there is supply if the exporters are unable to produce.

Whatever option is chosen, it is still necessary to reduce food wastage. In addition, people should be encouraged to have a healthier and more diverse diet to lessen the reliance on rice. Furthermore, the CASO must continuously strive to improve rice productivity by adopting relevant technologies while—at the same time—balancing the impact of increased production to the environment.

Unfortunately, there are no such options for Sorsogon City's energy situation. It has no choice because it has to use the grid system for electricity distribution. Section 5 of the Implementing Rules and Regulations of the Electric Power Industry Reform Act says that powerplants are prohibited from directly serving end-users. Thus, the geothermal and hydropower generation facilities in the city can only sell electricity through the Luzon grid.

What the city leaders can do is to help SORECO II decrease its distribution systems loss, which is partly caused by electricity theft . The Anti-Electricity Pilferage Act of 1994 punishes electricity thieves, but more can still be done regarding its implementation. Sorsogon City may pass an ordinance mandating barangay chairpersons to check for pilferage in their areas and provide rewards to people who will report instances of theft. It must be noted that unlike water losses, the cost of which is borne by the SCWD, the cost of electricity systems loss is passed on to consumers. This is because—scientifically and technically—power generation, transmission, and distribution can never be 100 percent efficient. However, to protect consumers, the government has set a cap on the systems loss that electric utilities can charge .

As for water supply, although the SCWD has a projection that there will still be enough potable water in the next 10 years, the estimate is true only for the barangays served by the utility. There is no accounting

for the long-term availability in the BAWASA areas. Thus, it would be prudent for the city leadership to mandate—where technically feasible—all barangays to connect to the SCWD. The 50-percent systems loss of the BAWASAs are simply too high. In addition, such a policy would address health issues. The BAWASAs cannot match the capabilities of the SCWD to ensure the cleanliness of water. Finally, non-SCWD sources are mostly level I and II facilities. Providing all residents with piped-in water into their homes will greatly improve their standard of living.

Meanwhile, the current irrigation system using open conveyance channels leaves very little room for the city to reduce the water requirement for rice production. It would, however, be too expensive to utilize other irrigations systems. Thus, irrigation operators should explore irrigation scheduling schemes that could lessen the amount of water being diverted without jeopardizing yield. One technique is the alternate wet and dry method, which also mitigates methane emission.

Looking at water quantity during a one-year period, it can be concluded that there is enough water to supply the demand for agriculture and other uses in the city. However, if scrutinized at finer time-steps within the one-year period, it is observed by the residents that there are times that water shortage is experienced in some areas due to conflicting demands from agriculture, power generation, domestic, and other uses. In the future, these conflicts will be more pressing due to the projected increase in population, new industries, and climate change. The city may need to come up with a policy on water scheduling and prioritization for the different water-using sectors in the future.

Looking at the quality of water post-irrigation, the nutrient load (particularly phosphates and nitrates) ought to be considered by the city. The current policy on organic agriculture somehow contributes in this aspect because less agro-chemicals would be present in the water discharged from rice farms. The city can couple the present organic agriculture ordinance with policies on proper fertilization, such that only a manageable amount of nutrient load is contained in agricultural runoff.

For the long term, Sorsogon City must have the capacity to recycle wastewater because it is a huge step toward resource conservation. At present, only the liquid waste from the public market and slaughterhouse are treated. This is understandable because treatment facilities are expensive and require long-term planning. However, the best time to start planning is now. The city needs to take steps that will eventually lead to its having a sewerage system, in compliance with the Clean Water Act of 2004.

It is also time to crack down on the illegal extraction of construction materials in Sorsogon City. Unregulated quarrying and logging will take their toll on the environment, which will adversely affect water supply and quality. The city has to stop these illegal activities for the benefit of all residents. Quarrying must be managed properly for it to bring positive results. Sustainable quarries can lead to a reduction in the reliance on imported resources. They may also aid in maintaining the capacity of the rivers, hence abating floods. If these quarries are regulated and taxed, Sorsogon City will earn revenues.

Today, the construction materials in the city have not reached the end of their useful life so construction waste is nil. However, as early as now, Sorsogon City should have a policy on how to manage this waste. It can mandate recycling and exporting instead of the materials being thrown away.

Interviews with key informants have shown that traffic in the business district is getting worse. An expert from the UN Environment said that current international consensus hews toward cities having only one compact business center (S. Gil, personal communication, December 6, 2017). However, due to the congestion in the business district, a new city hall has already been constructed in another area. Since this compound houses all important government offices and the new central transport terminal is nearby, it is expected that commercial establishments will open up in the neighborhood—thereby creating a second business center. This emerging business district is not yet congested, so the city still has time to craft appropriate policies to make sure that the sustainability of the area is at the forefront of urban planning.

To mitigate the negative effects of urbanization, Sorsogon City needs to set aside at least 24 hectares more open spaces to meet the requirements of national laws. Having open areas also mean more recreation spaces

for residents, better environment quality, and more protection from storms .

These green spaces will have positive effects on water and energy use. More vegetation means that water is retained much longer in the soil . In addition, more vegetation would help cool the environment and reduce urban heat islands—thereby lessening the need for air-conditioning, which entails much energy .

Instead of constructing conventional treatment plants, the city can build rain gardens and other similar green techniques to treat wastewater. This can be incorporated in the overall landscaping of the open spaces by using plants that are not only functional but aesthetically pleasing as well. They can be useful in arresting floods if placed in strategic locations.

One interviewee said that there are forestlands on the edges of the city, but these are generally inaccessible. Thus, it is recommended that the city construct more roads to these areas. Doing so can jumpstart ecotourism, which can bring in revenues.

Another key informant noted that if fruit-bearing trees are planted in open spaces, fruits may be harvested for local consumption. Additionally, the shade that the trees provide will encourage more people to walk and reduce the need for gasoline or diesel to power motor vehicles.

The project team had immense difficulty obtaining data during the research phase. Thus, a number of informants suggested that Sorsogon City establish a management information system (MIS). According to Ingram , an MIS "is a set of systems and procedures that gather information from a range of sources, compile it, and present it in a readable format."

This is a very good recommendation that the mayor agreed with. Having a policy on the gathering, storing, and retrieving of information is very important because the data generated can provide decisionmakers with an overview of the issues they are dealing with.

A noteworthy finding is that Sorsogon City has a relatively low population growth rate of 1.54. However, the city is urbanizing so it is inevitable that the growth rate will rise in the near future. Hence, decisionmakers should adopt policies that will temper population growth while considering the culture and acceptable norms of the community. Doing so will reduce the strain on natural resources and keep importations in check.

Acknowledgment

The researchers would like to thank the League of Cities of the Philippines, UN Environment, Bicol University, Sorsogon State College, and the local government of Sorsogon City for making this study possible.

The Authors

Naz, Gremil Alessandro A. is assistant professor at Bicol University. He has master's degrees in communication from the University of the Philippines and New York University.

Bilaro, Virgil B. is instructor at Bicol University. He has a master's degree in environmental engineering from the University of the Philippines.

Torres, Erwin E. is a licensed environmental planner and assistant professor at Bicol University. He has bachelor's and master's degrees in economics from the University of the Philippines and Bicol University, respectively.

Bartolata, Richard L. is a registered nurse and an associate professor at Bicol University. He finished his master's in nursing and Ph.D. in Educational Management at Bicol University and Masbate Colleges, respectively.

Balmadrid, Davie B. is instructor at Bicol University. He has a master's degree in information technology from Aemilianum College.

Desuyo, Shiela B. is instructor at Bicol University. She has bachelor's and master's degrees in economics from the same university.

Belgica, Ricardo M. is professor at Bicol University. He has a BA in economics, master's in public administration, and Ed.D. from the same university.

Janer, Susan S. is professor at Sorsogon State College. She finished her bachelor's, two masters', and doctoral degrees in education at Bicol University.

Deri, Ritzelda A. is professor at Sorsogon State College. She finished her bachelor's, master's, and doctoral degrees in mathematics education at Bicol University.

Miranda, Franklin Jr. M. is instructor at Bicol University. He has a master's degree in information technology from the University of the Cordilleras.