

# Rethinking renewable energy based on biowaste in Amazonian communities

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Amazónica IKIAM



**Ikiam**  
Universidad Regional Amazónica

Date:  
March 23, 2023





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Costa Rica

Wildlife guide

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Costa Rica

Wildlife guide

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Cuba

Havana pull-out map

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Ecuador & the Galápagos Islands

Just Landed card

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Ecuador & the Galápagos Islands

Just Landed card

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Egypt

Top sights in full detail

lonely planet

Egypt

Top sights in full detail



# ECUADOR REGIÓN COSTA





# Amazon Region

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**40%**

**SOUTH AMERICA**



400

SOUTH AME

# Indigenous Ecuador

Ecuador's diverse indigenous population is made up of nearly four million people, with approximately 25% of Ecuadorians (another 65% of the population are mestizo, with mixed indigenous and European ancestry). There are more than a dozen distinct groups, each speaking some 20 different languages. Historically, Ecuador's native people have faced heavy discrimination and abuse from early Europeans, and today's groups face daunting challenges – particularly from the loss of lands owing to deforestation.

## Present-Day Challenges

Ecuador's indigenous people have suffered from centuries of discrimination and remain at the bottom of the country's highly stratified social-class structure. It's a well-known truth that if you're indigenous in Ecuador, you're more likely to be poor, have fewer years of education, and have less access to basic healthcare. According to a report from the World Bank, poverty among Ecuadorian indigenous people is widespread and reaches 96% in the rural highlands. To make matters worse, deforestation, drilling, mining and logging has led to the widespread displacement of indigenous groups or to the polluting of their natural environments. A \$18 billion lawsuit against Texaco (which is now owned by Chevron) over the heavy petro-contamination of the Amazon is but one high-profile example.

Despite enormous hardships, indigenous people have made enormous strides on the political front. Through marches and popular uprisings, the Confederation of Indigenous Nationalities of Ecuador (CONAIE) has lobbied for greater autonomy and land reform – protesting, in particular, the expropriation of indigenous lands to multinational companies. Since its founding in the 1980s, CONAIE's political power has grown, and the government has made a few concessions – granting 16,000 sq km of land to indigenous groups in 1992 and giving them greater autonomy and recognition in the new constitution, drafted in 2008.

## Kichwa

The country's largest indigenous ethnic group, the Kichwa number well over two million. They live in both the Sierra and the Amazon, and are

## LOVE & WAR AMONG THE SHUAR

One of the most studied Amazonian groups, the Shuar were once feared as 'headhunters' and had a reputation for being fierce warriors – in fact, they were never conquered by the Spanish. Up until the mid-20th century they were famous for the elaborate process of tzantza, shrinking the heads of slain opponents. Shuar believed the *musak* (soul) of the victim remained inside the head and that keeping the tzantza would bring the warrior good fortune and please the spirits of his ancestors. Shuar men take one or two wives, and girls are often married between the ages of 12 and 14. Unlike in some other societies, women are given autonomy in the marriage: those that are dissatisfied with their husbands can leave and return to their families. The men, however, cannot abandon their wives (those that run off will be brought back by the wife's family!). Outside marriage, some Shuar take lovers, which may or may not be tolerated by the spouse. Older wives sometimes take it upon themselves to teach younger unmarried men the arts of lovemaking, and having multiple partners is not necessarily frowned upon. Nevertheless, misunderstandings are not uncommon, and bloody, long-standing family feuds have sometimes resulted from such infidelities.

## Huaorani

Short in stature (men average 1.5m or about 5ft tall), the Huaorani are an Amazonian tribe living between the Río Napo and the Río Curaray in the Oriente. They number no more than 4000 and remain one of Ecuador's most isolated indigenous groups. They have a reputation for being warriors, defending their territory against outsiders – whether rival tribes or oil developers. They have a complex cosmology – making no distinction between the physical and spiritual worlds – and an intimate understanding of the rainforest in cultivating medicine, poisons for defense and hallucinogens for spiritual rites. Some still refer to them as the Aucas, meaning 'savage' in Kichwa, which the Huaorani find extremely offensive.

## Shuar

Until the 1950s the Shuar, from the Amazonian lowlands, were a society of male hunters and female gardeners. To preserve their culture and lands, the Shuar (who today number 40,000) formed the first ethnic federation in Ecuadorian Amazonia in 1964. Traditionally, they were seminomadic, practicing small-scale slash-and-burn agriculture, planting crops (such as yuca and sweet potato) and moving on before the soil was depleted. Like other Amazonian groups, Shuar shamans administer *ayahuasca*, a psychoactive infusion, to reach higher planes of consciousness in spiritual practices.

## Chachi

The Chachi originally lived in Ecuador's highlands, but fled to the Pacific coast (to present-day Esmeraldas province) in the wake of Inca and Spanish conquest. With a population of around 4000, they live in homes built on stilts over a watery landscape.

For insights into the customs and cosmology of the Shuar, read *Spirit of the Shuar* (2001) by John Perkins and Shakaim Chumpi. Through interviews with members of the Amazonian tribe, Perkins explores Shuar warrior culture, healing and sexual practices, spiritual beliefs and challenges in the face of ever-encroaching development.

# Contents

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The global energy matrix



02

Waste management in developing countries



03

From organic waste to energy transition



04

Biomass as a bioenergy alternative





Part 1:

# Currently world energy matrix



# Environmental impacts

The world's energy matrix depends on of fossil fuels, which are responsible for disastrous impacts.



①

One of the most relevant is the uncontrolled emission of CO<sub>2</sub>, which leads to the intensification of global climate change.

②

The contributions to the environmental impact occur in all cases in the early stages of waste disposal and the rate of decomposition together with the distribution of the impact over time increase in warm regions.

③

Proper waste management is essential in these regions to control and minimize its possible impacts.

The background of the slide features a photograph of several tall, dark communication towers silhouetted against a bright orange and yellow sunset sky. The towers are of varying heights and are equipped with various antennas and equipment at their tops. The sky transitions from a deep orange at the bottom to a pale blue at the top.

# Isolated systems, the Amazon

Rethinking renewable energy based on  
biowaste in Amazonian communities

Only a small percentage of the country's energy production capacity is outside the electricity system, in small isolated systems, mainly in the Amazon region.

Many of these isolated systems have precarious access to energy due, in part, to efforts to keep the forest well preserved.

(Mendes et al., 2019; Ziegler et al., 2019)



One of the rituals that are carried out is the GUAYUSUPINA whose main biofuel is firewood, which are dry sticks brought from the traditional CHAKRA.

The elements to form biogas are the rest of cassava, plantain and corn

**Plantas alimentarias de la chakra kichwa en la comunidad Alto Tena, Amazonía, Ecuador 1**  
**Edible plants of the Kichwa "chakra" at the Alto Tena community, Amazonian Ecuador 1**

Montserrat Rios<sup>1</sup>, Steven M. Ramírez Oviedo<sup>2</sup>, Rusbel Chapalbay<sup>3</sup> & comunidad Alto Tena  
<sup>1</sup>Universidad Regional Amazónica Ikiam, <sup>2</sup>Valley Nature Center & <sup>3</sup>Cooperación Técnica Alemana

Producido por/Produced by: Montserrat Rios, Álvaro J. Pérez Castañeda, Erika Zambrano, Ronald Rivera, Tatziana Wachter & Nigel Pitman  
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 X. Comejo, Ddemelo, R. Foster, J. de Freitas Luz, J. Granados O., A. Grygas, S. Holt, A. Kay, B. Mom, W. Poveda, G. Sturm & Yang  
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 [fieldguides@fieldmuseum.org] [1113] versión 1 3/2019



Soria Grefa recolecta yuca en chakra, comunidad Alto Tena, Amazonía, Ecuador  
 Sonia Grefa gathering cassava in "chakra", Alto Tena community, Amazonia, Ecuador



**1 Achukcha**  
 Achajcha  
*Cyclanthera pedata* CUCURBITACEAE



**2 Ananas**  
 Chirimoya  
*Ananas muscass* ANNONACEAE



**3 Avío**  
 Avío, coimbita  
*Pouteria coimbita* SAPOTACEAE



**4 Chunta**  
 Chonta  
*Bactris gasipaes* ARECACEAE

Dear brothers and sisters  
who see us, the  
Amazonian Kichwas, we  
live in a time of changes  
and damage to the  
ecosystem, our rivers,  
jungle, and animals are no  
longer as before.



But the communities, peoples, and nationalities need to know how to maintain  
nature, in this sense.

Talking about renewable energies will allow us to keep nature alive as it was  
before best regards to all

# Guayusupina



A photograph of a massive landfill of unsorted waste, including plastic bags and debris, under a hazy, orange-tinted sky. Numerous birds are seen in flight across the sky, some appearing to be scavenging for food. The scene is a stark representation of environmental waste management challenges in developing countries.

Part 2:

# **Waste management in developing countries**

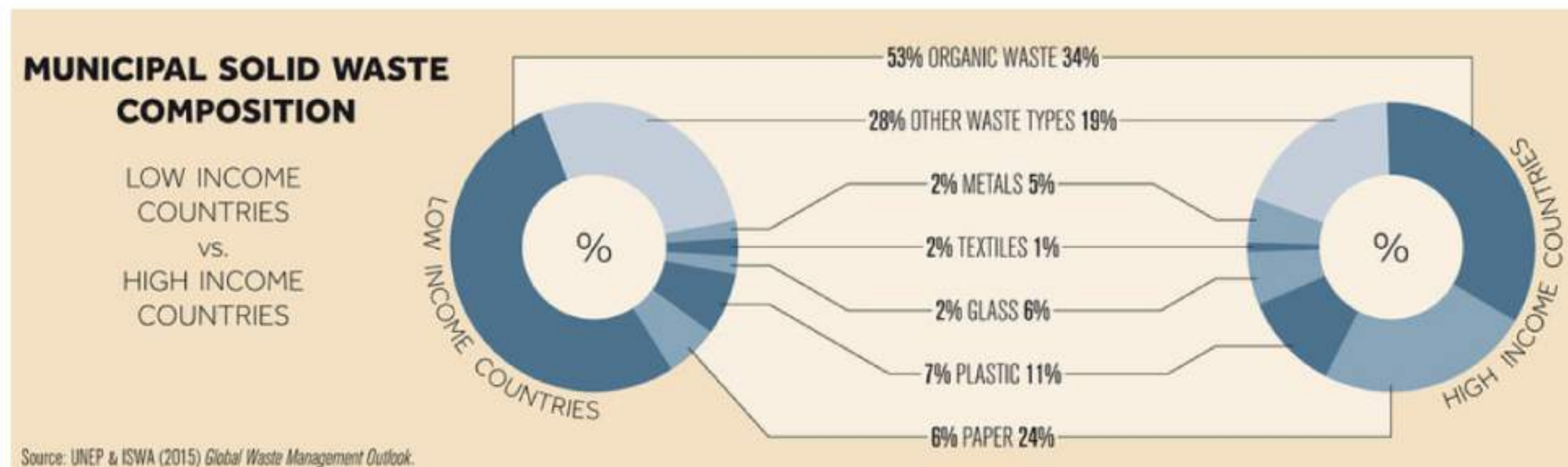
# Developed countries

vs.

# Developing countries

There are huge differences in terms of the generation, composition and management of waste between the two groups.

- With a better level of income, a higher generation of waste.
- The trend is to seek more integrated and sustainable waste management systems
- The struggle continues to move from the disposal of waste in open-air dumps to controlled sanitary landfills
- It is important to clarify that the European case studies may not be representative of the LCA scenario due to their technological and geoclimatic conditions.



(Ziegler et al., 2018)





# Overview of the MSWM in Ecuador

## RESEARCH ARTICLE

### Evaluation of municipal solid waste management system of Quito - Ecuador through life cycle assessment approach

*Avaliação do sistema de gestão de resíduos sólidos urbanos de Quito - Equador através de análise de ciclo de vida*

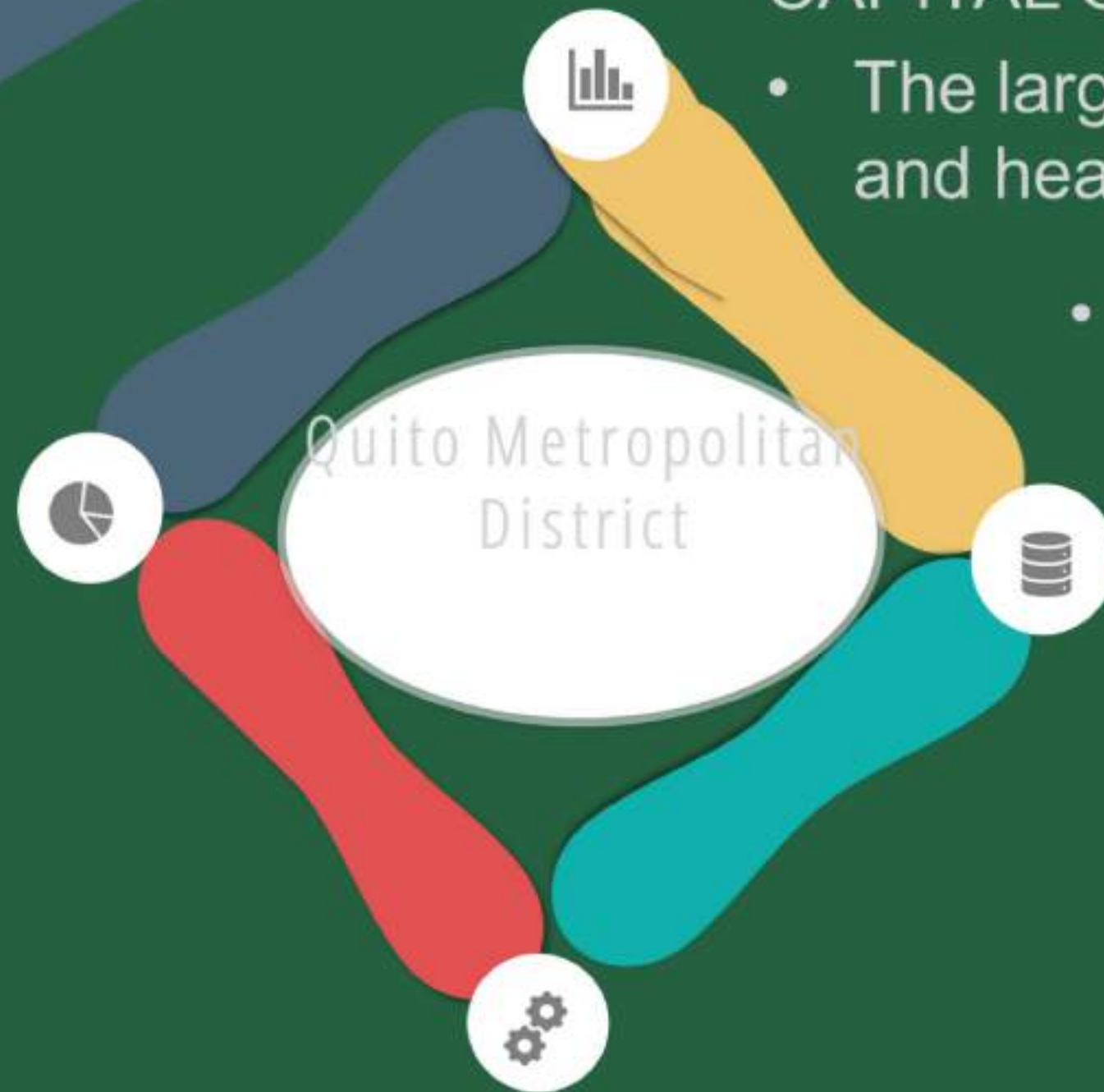
*Evaluación del sistema de gestión de residuos sólidos urbanos de Quito - Ecuador mediante análisis de ciclo de vida*

Cristhian David Chicaiza Ortiz<sup>1,2\*</sup>   
Vanessa Pamela Navarrete Villa<sup>2</sup>   
Christian Orlando Camacho López<sup>3</sup>   
Ángel Fabián Chicaiza Ortiz<sup>3,4</sup> 

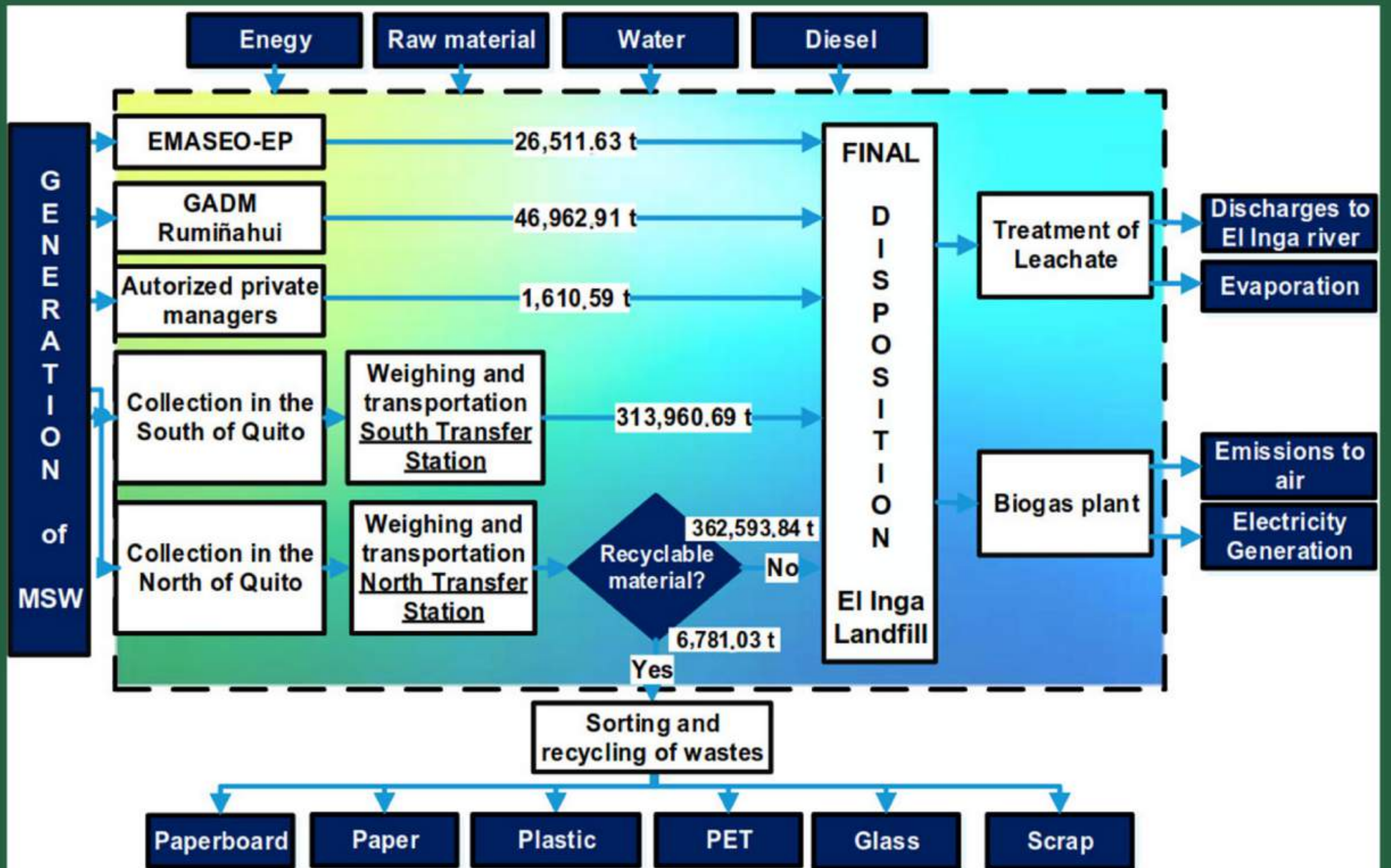


## CAPITAL OF ECUADOR

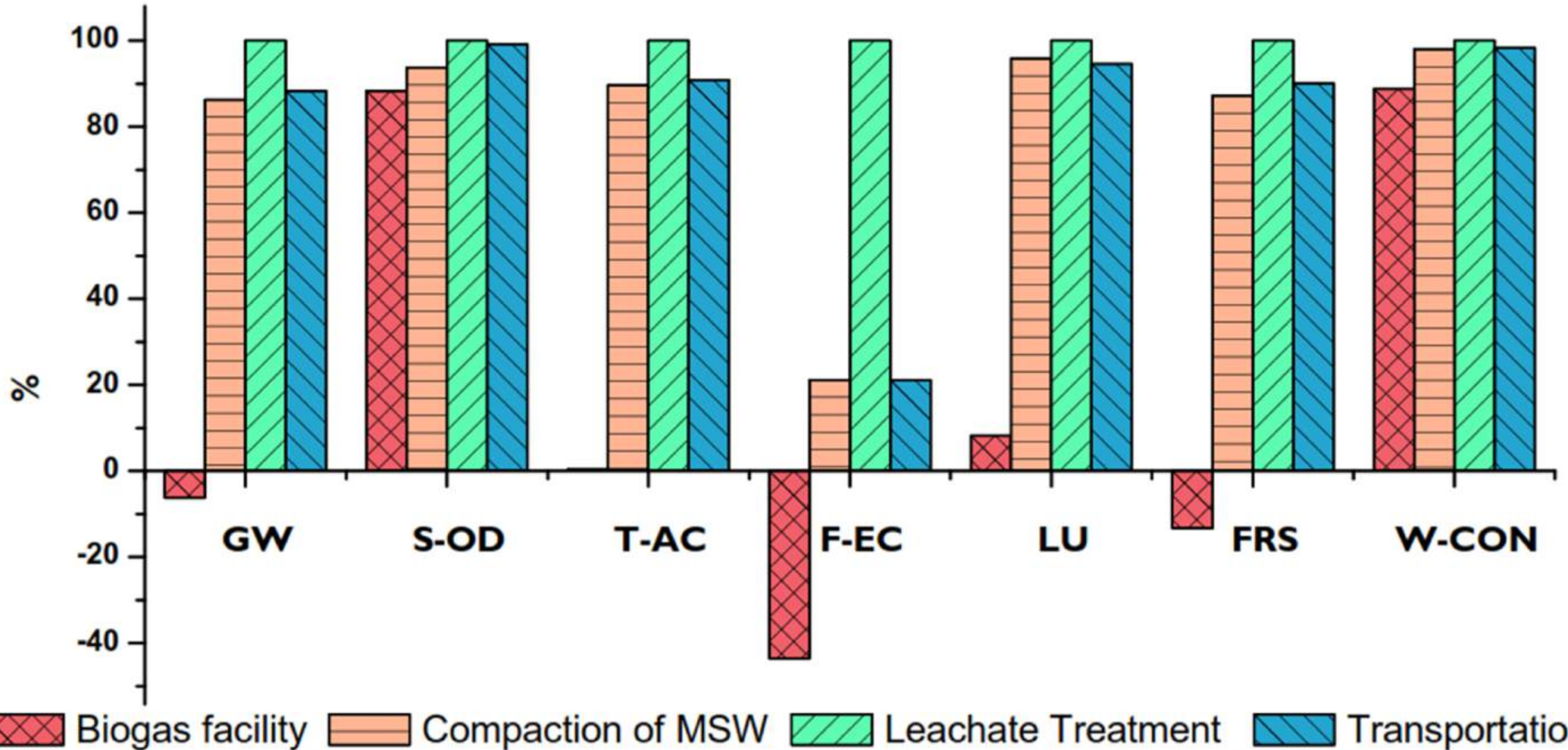
- The largest city in terms of national GDP and headquarters of the main companies.
- Approx. 2000 tons/day of MSW are collected, ending in the landfill El Inga.



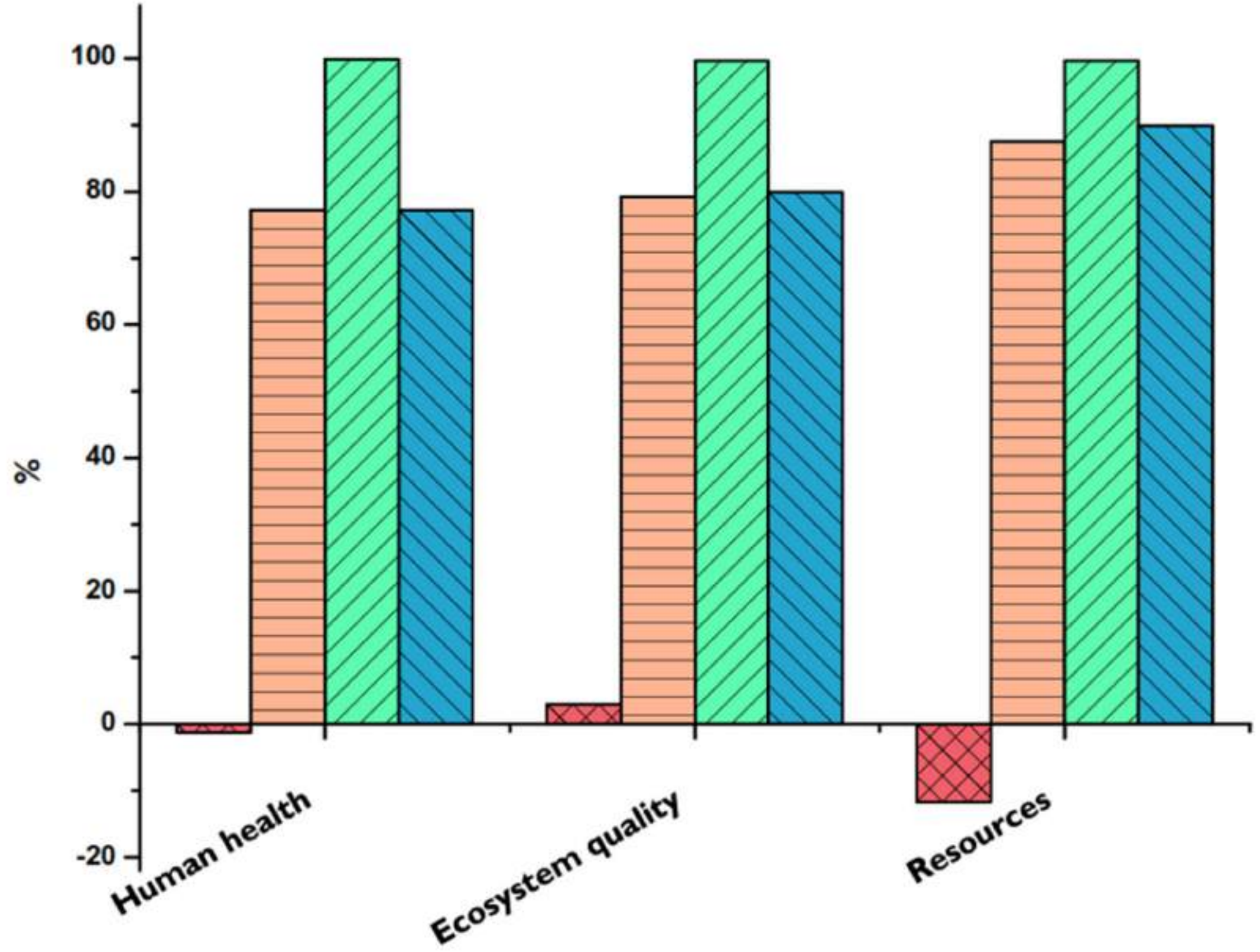
**Objective:** Evaluate the MSWM of Metropolitan District of Quito through an approach of LCA



# Midpoint approach



# Damage approach



Biogas facility    Compaction of MSW    Leachate Treatment    Transportation

# Impact in the Amazon region

The generation and composition of waste vary depending on some conditions:

- Socioeconomy
- Climate
- Geography
- Cultural conditions
- Waste planning systems
- Eating habits

Sanitary landfills located in areas with hot tropical climates and high organic matter content will have:

- higher LFG generation
- higher leachate generation

**Temperature directly affects the anaerobic decomposition rates of waste.**



A top-down view of a compost bin. A hand is seen placing a piece of green vegetable waste into a small white cup. The bin is filled with various organic materials: banana peels, orange peels, a sliced lime, a tomato, a cucumber, a beet, and several eggshells. Green leafy vegetable scraps are also visible. The compost bin is situated on a bed of dark, rich soil.

Part 3:

# From organic waste to energy transition

# Current energy characteristics in the Amazon region

01

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Oil dominates national energy, representing 80% of energy consumption, followed by hydroelectricity (16.6%), natural gas (3%) and renewable energies (0.7%).



Rethinking renewable energy based on biowaste in Amazonian communities

02

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Part of the conservation argument is based on environmental protection, which is closely related to the negative record of the oil sector in the Amazon.



03

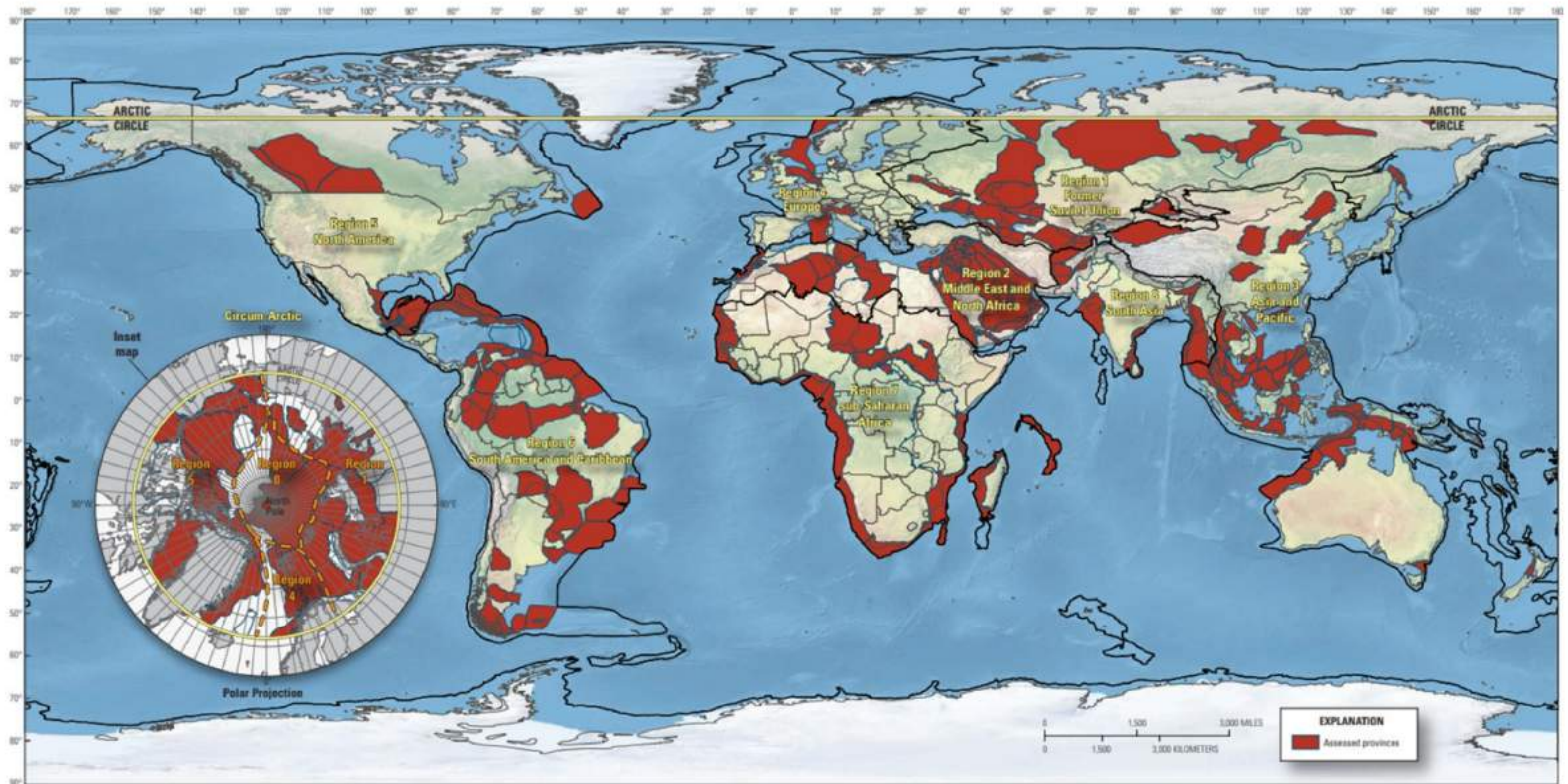
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Almost 70% of municipal solid waste is deposited in the open air and only 1.5% is used as an organic compound for agriculture. Leaving a high percentage that can be used as bioenergy.



(Mendes et al., 2019; Ziegler et al., 2018)

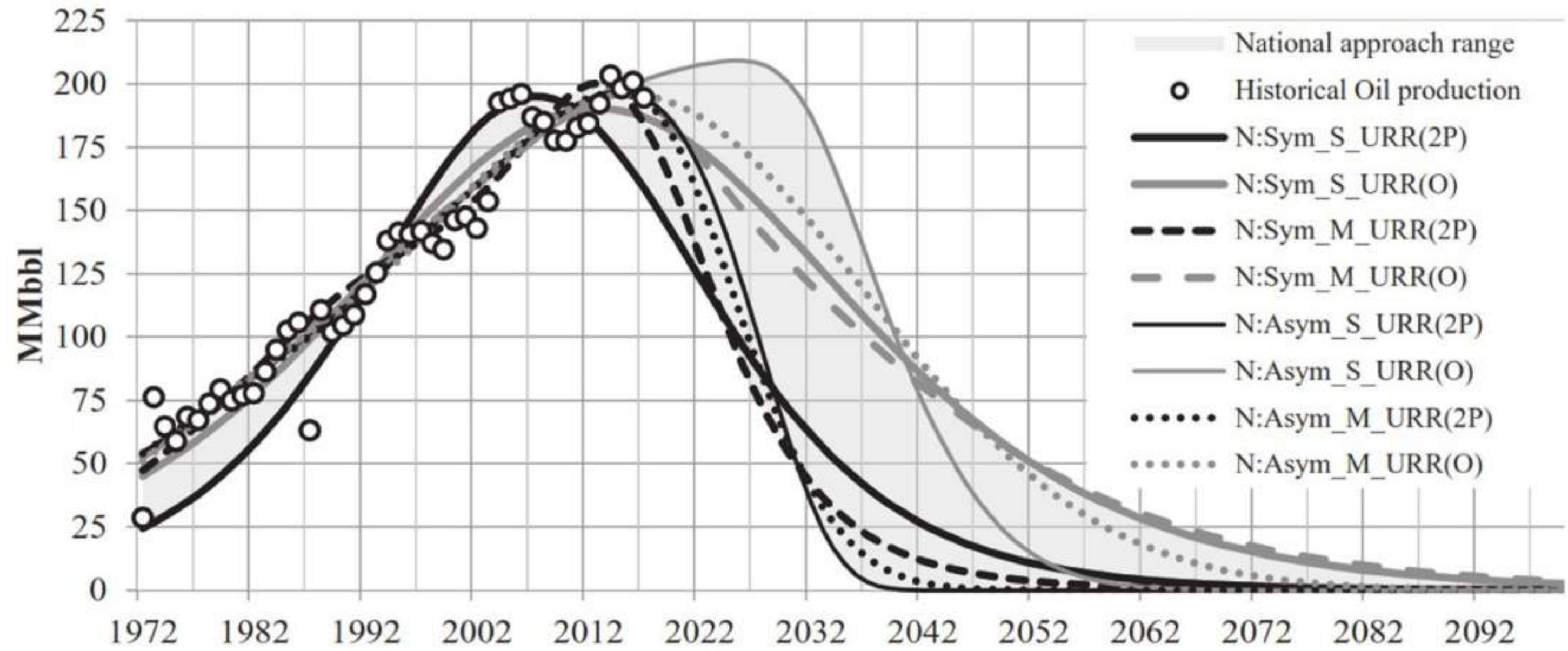
# World oil reserves



(Schenk et al., 2012)



# Impacts of oil in Ecuador



(Espinoza et al., 2019)





# Mercados de Tena

## Low cost digesters as urban wastewater treatment system for rural communities



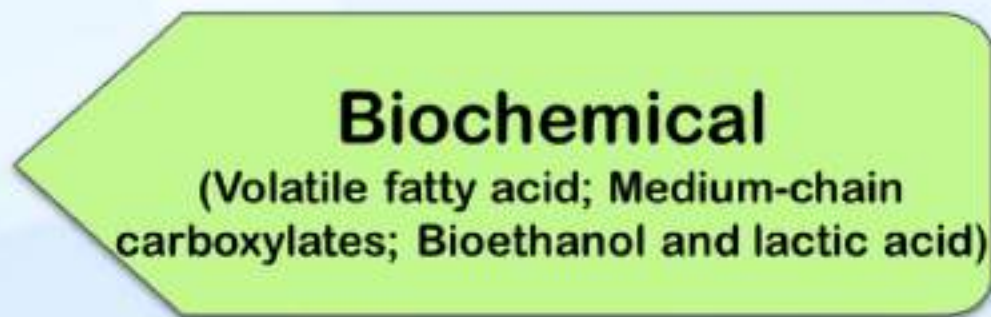
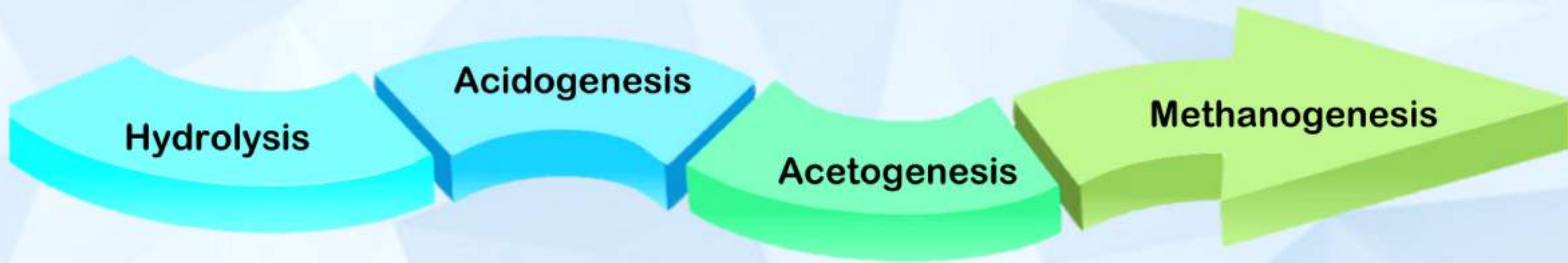
**Biodigestores de bajo costo como sistema de tratamiento de aguas residuales urbanas para las comunidades rurales de la Amazonía ecuatoriana.**

**1° En Ikiam validamos la tecnología (*acabando*)**

**2° Implementamos y validamos en una Comunidad (Cotundo, Archidona) (*Empezando*)**



**Jaime Martí**



Iron-based materials



Carbon-based Materials



Biological Additives

Resources Recycle

Anaerobic Digestion

Additives

It decomposes organic matter to generate biogas (methane, carbon dioxide, etc)



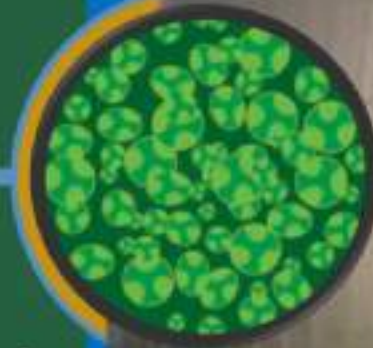
-Mesophilic  
(77°F–100°F)

-Thermophilic  
(122°F–135°F)



It represents a renewable energy

Feedstock: biosolids, livestock manure, and wet organic materials and MSW



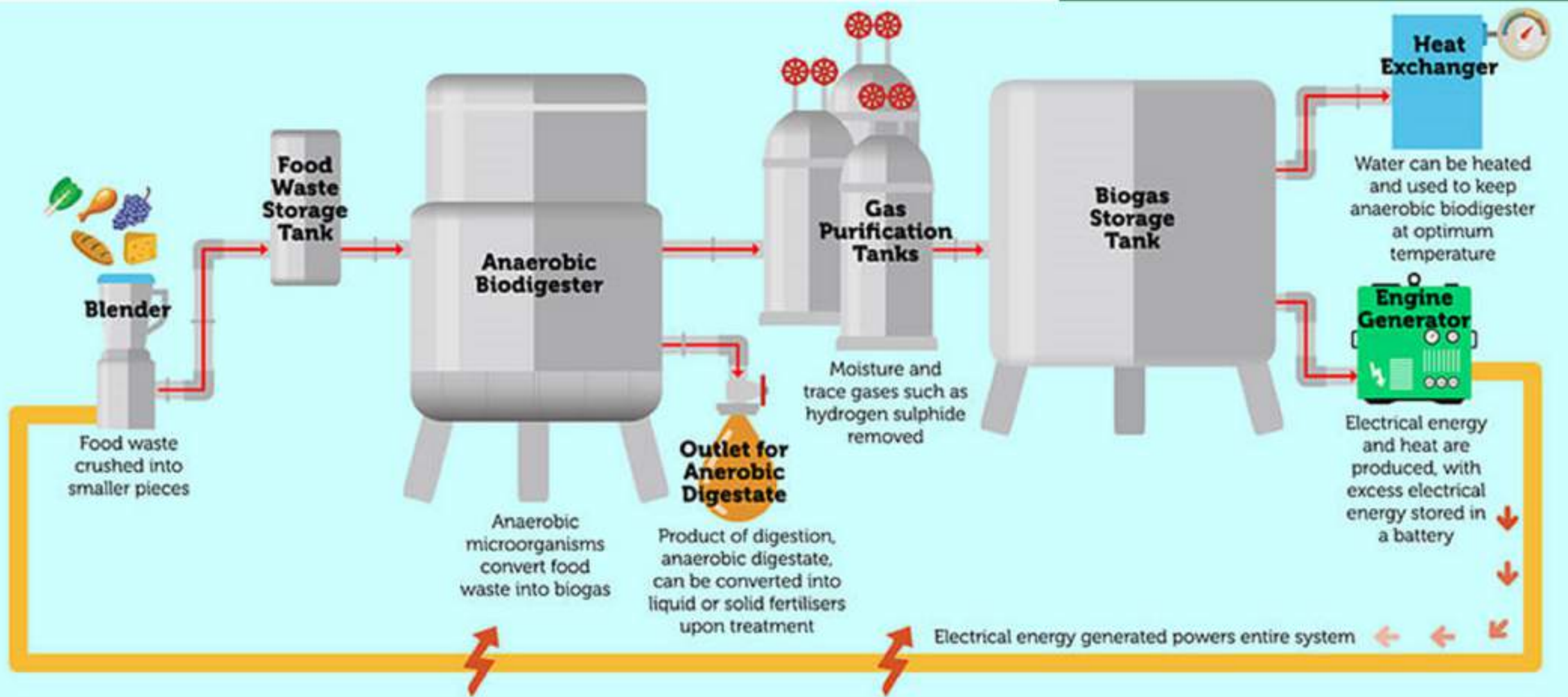
(Beyene, Werkneh and Ambaye, 2018)

Egg-shaped digesters –  
Xiao Hong Men UWTP, Beijing/China



Assessn  
decentr  
system  
CHP fo

Jingxin Zhang<sup>a</sup>  
Yen Wah Tong<sup>b, c</sup>

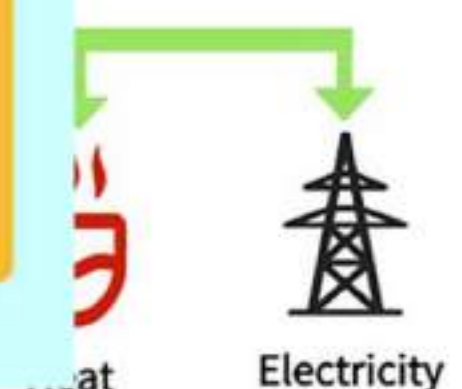


Anaerobic digester      Biogas engine



Increased 135%      87%

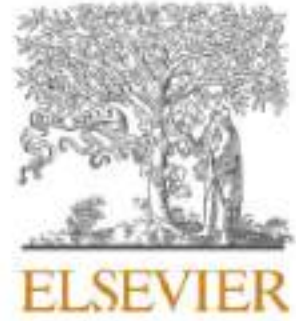
Optimization scale-up system



# RECYCLE FOOD WASTE

TO CHARGE ⚡ YOUR PHONE





## Enhancement of methanogenic performance by gasification biochar on anaerobic digestion

Qiuxian Qi<sup>a</sup>, Chen Sun<sup>f</sup>, Chicaiza Cristhian<sup>a,g</sup>, Tengyu Zhang<sup>d</sup>, Jingxin Zhang<sup>a,\*</sup>, Hailin Tian<sup>b</sup>, Yiliang He<sup>a,e</sup>, Yen Wah Tong<sup>b,c</sup>

<sup>a</sup> China-UK Low Carbon College, Shanghai Jiao Tong University, Shanghai 201306, China

<sup>b</sup> Environmental Research Institute, National University of Singapore, Singapore

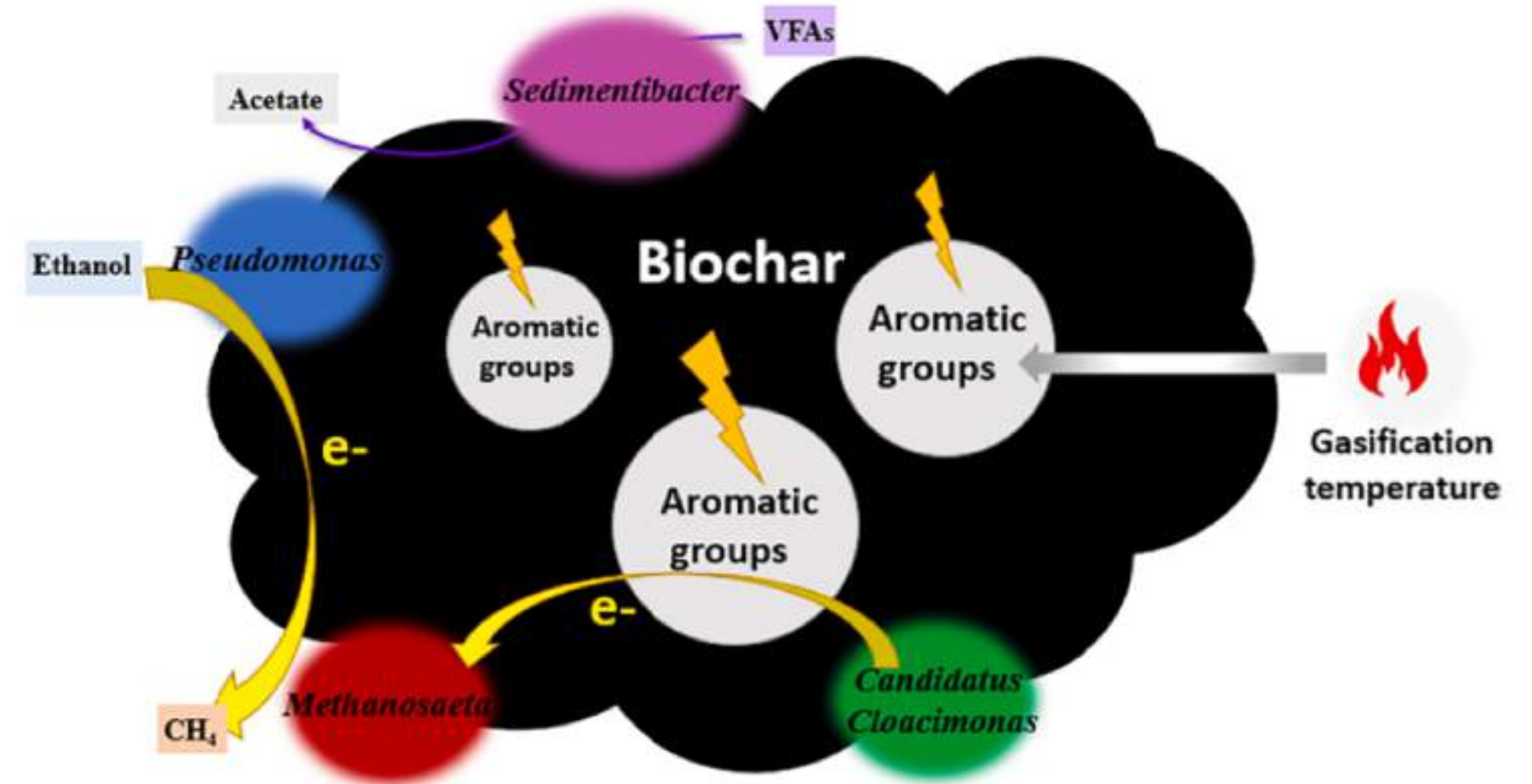
<sup>c</sup> Department of Chemical & Biomolecular Engineering, National University of Singapore, Singapore

<sup>d</sup> Department of Chemical and Biological Engineering, University of Sheffield, Sheffield, UK

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# Current energy characteristics in the Amazon region



Rethinking renewable energy based on biowaste in Amazonian communities

A unique feature of the Amazon region is its many isolated, riverine communities.

1 A reduced and decentralized consumer market, in which kilometers of cables are needed to supply a single home, due to the vast territorial dispersion.

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2 Difficult access, which is done predominantly by boat or plane, generating costs based on the transport of fossil fuel by river.

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(Escribano, 2013; Mendes et al., 2019)

# Current energy characteristics in the Amazon region



Rethinking renewable energy based on biowaste in Amazonian communities

A unique feature of the Amazon region is its many isolated, riverine communities.

3

The prohibition of passing on various operating costs, due to the low level of income in local communities.

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4

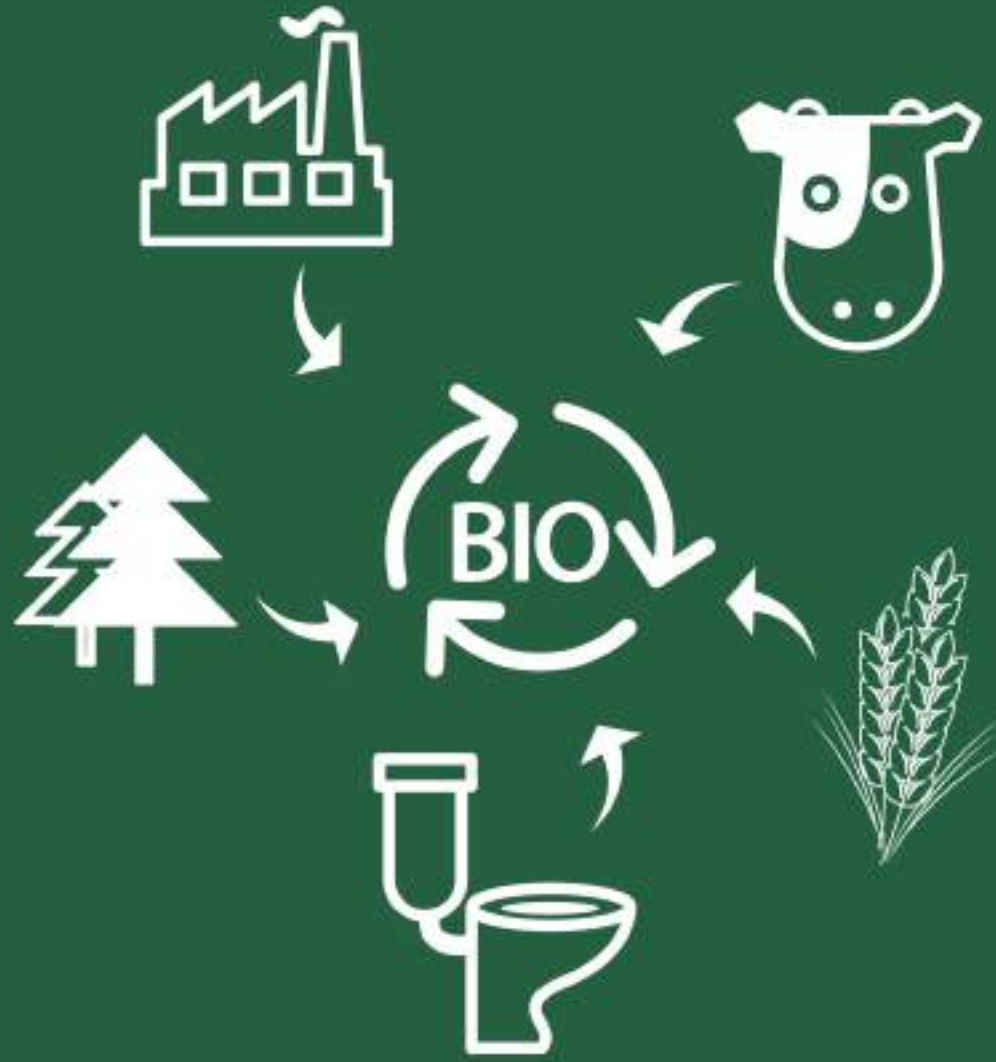
Lack of technical backgrounds generate loss in the generation and distribution systems, leading to significant financial losses.

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(Escribano, 2013; Mendes et al., 2019)

# Energy potential assessment



1

Lignocellulosic biomass is a promising alternative for the energy sector worldwide.

2

The Amazon presents the **ideal availability biomass residues** that do not compete with food production

3

If all agricultural residues were converted into energy, **64% of energy needs would be covered**





# Biomass conversion technologies

## Biochemistry.

It uses microorganisms that carry out a catabolic route based on the degradation of complex organic compounds to obtain simpler substances and energy, which is generated by breaking the bonds of large molecules.

Rethinking renewable energy based on biowaste in Amazonian communities

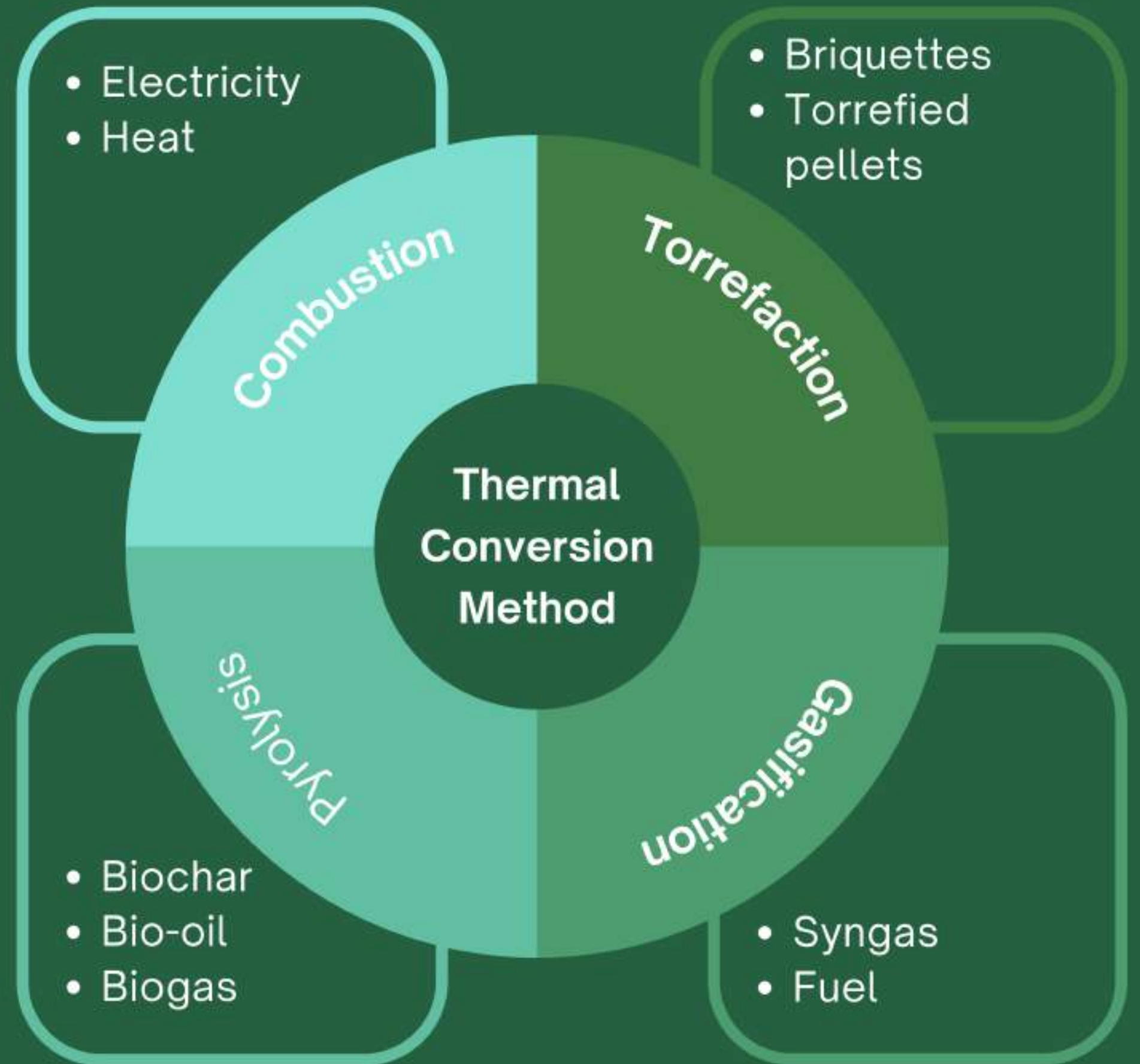


## Thermochemistry.

Are those that transform biomass, under certain conditions of pressure and temperature, to obtain solid, liquid or gaseous products.

(Araujo et al., 2021)

# Biomass conversion technologies





# Available biomass resources in the Amazon region

- It is important to have knowledge of biomass residues that are available in each region for energy production.
- 
- Numerous investigations have evaluated the energy potential of certain biomass residues to explore the viability of the production of fuel briquettes.
- 
- In this way, the conservation of forest species is guaranteed and, consequently, it identifies regional features.





Part 4:

# **Biomass as a bioenergy alternative**

# Biomass potential



## Expenses

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The energy source will be obtained locally as a by-product, therefore the cost will be lower increasing the community autonomy.



## Development

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A sustainable management and reduction of CO2 emissions might generate incomes by carbon credits and forest protection programs.



## Sustainability

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The use of biomass within Life Cycle approach (first as a feedstock for, and then as an energy source) might reduce greenhouse gas emissions.



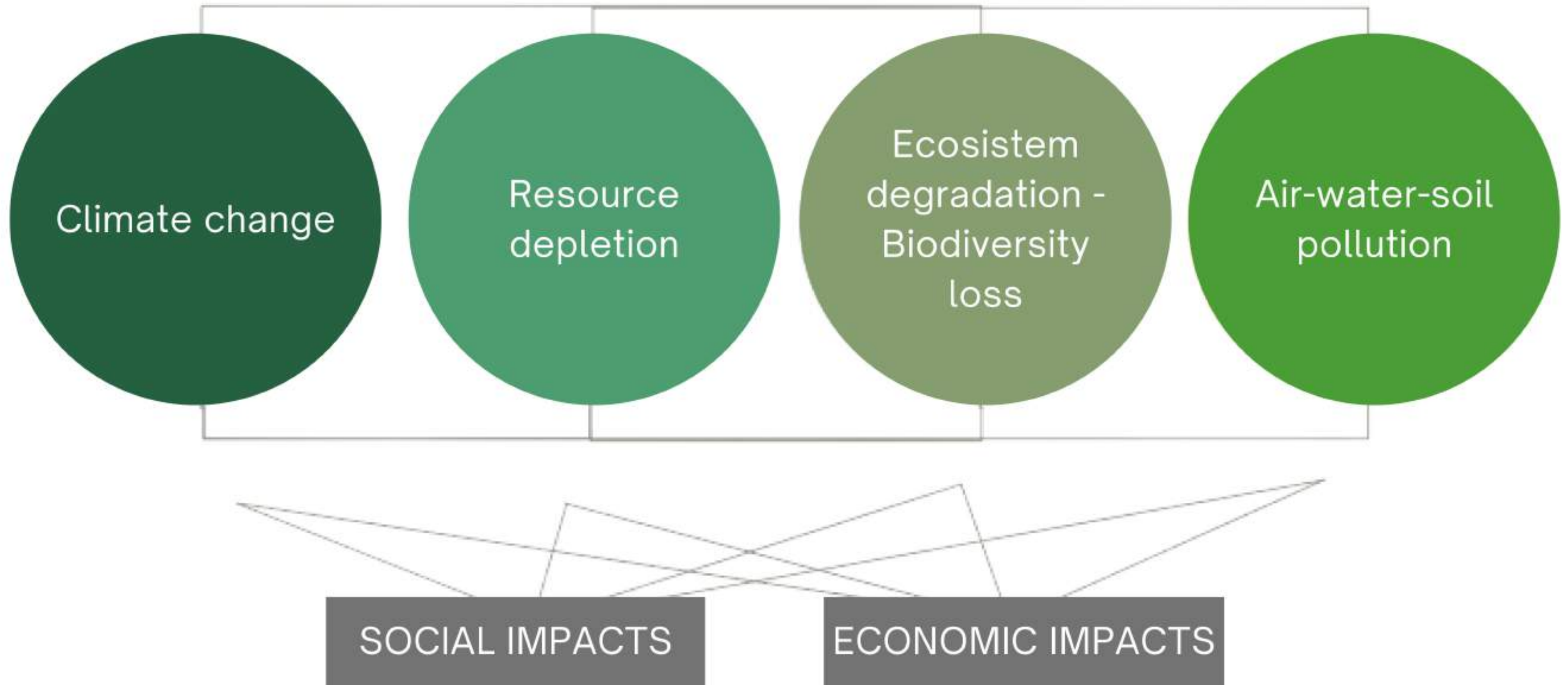


# Evaluation of specific criteria

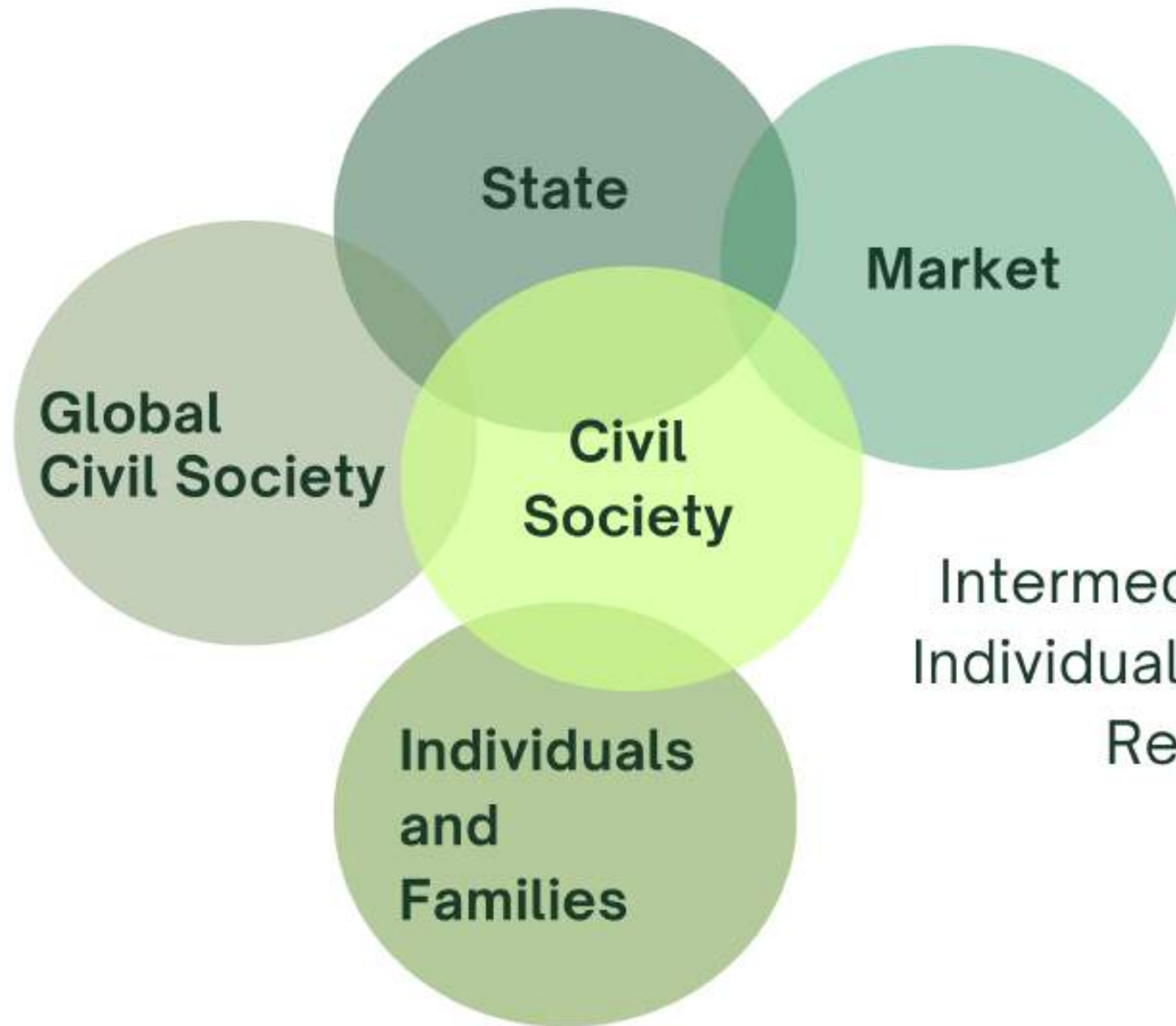


The use of biomass for energy in communities has a positive environmental, social, cultural and political impact, in this way it is possible to promote sustainable development in the region, protecting the ecosystem of the Amazon rainforest.

# Evaluation of specific criteria



# Evaluation of specific criteria



Intermediate level between Individuals and State  
Individuals coming together to pursue public goals  
Represent the interests of individuals

# Biomass characteristics to consider:



When biomass is used directly as a biofuel, it faces certain challenges.

## Moisture content

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It is necessary ensure drying () without the loss of caloric power, due to the high moisture content.  
- 20%

## Composition

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As it has a heterogeneous composition, fundamental studies are needed on each type of biomass to define which feedstock will obtain the highest yield in biochar, biooil and synthesis gas.

## Calorific value

The superior calorific value expresses the maximum amount of energy that can be released when biomass undergoes conversion processes.

# Environmental Management Strategies in Kichwa Communities of the Ecuadorian Amazon

Cristhian Chicaiza-Ortiz<sup>1,2,3</sup>; Washington Logroño Vintimilla<sup>4,5</sup>; Ángel Chicaiza Ortiz<sup>6</sup>; William Núñez Chávez<sup>7</sup>; Marcia Ortiz Cañar<sup>8</sup>

## Abstract

Unemployment in Ecuador's Amazonian communities has increased significantly during the pandemic caused by the COVID-19 disease, primarily from March to August 2020; as a result, the population has shifted its focus to agriculture. This economy is specifically directed towards the overexploitation of timber resources and the hunting of animals. This study proposes an Environmental Management Plan for three agricultural farms located in the San Pablo de Ushpayaco parish, Napo, Ecuador, to sell primarily organic products in local markets. The fieldwork included a historical analysis of the sector, the diagnosis of environmental strategies, relevant environmental aspects, identification of actors, and interests regarding access to resources. Different problems include the inefficient use of water resources, poor land use management due to its overexploitation through monocultures, absence of sustainable agriculture and livestock practices, poor crop rotation, low application of organic fertilizers, and overuse of inputs and resources were identified. Poor agricultural practices have led to low production yields and limited economic opportunities for farmers. This Environmental Management Plan focuses on the prevention, mitigation, and compensation of the environmental impacts caused by agriculture and therefore improving the quality of life of the communities in the study case.

**Keywords:** Environmental management plan, sustainable agriculture, water management, agricultural management.

Table 2. Identification of programs that could contribute to solving these problems

| PROGRAM                       | SUBPROGRAM   | PROJECTS  | ACTIVITIES   |
|-------------------------------|--|---|--|
| Management of water resources | Assessment of water quality and its use in recreational activities and human consumption | Monitoring of water and its potential consumption | Implementation of a water catchment system<br>Physical-chemical analysis and registration of water quality every six months<br>Notification to the owners of the previous results for their potential use or consumption in certain activities<br>Location of points with tourist potential: adventure, spa, recreation with nature, also for academic research purposes |
|                               |  | Use for tourist purposes                          | Adequacy of the entrances with ecological trails, signage, labels with the scientific and common names of the representative species<br>Construction and adaptation of swimming pools for sport fishing  |
|                               | Use of water for the generation of electricity   | Harnessing as a source of electrical energy       | Measurement of water flow for the possible implementation of an electricity generation dynamo, near human settlements, poultry sheds, swimming pools and other productive areas that require lighting.<br>Adaptation of the electrical system for lighting homes, sheds, etc. and to move medium-sized machinery   |

|   |                                    |                           |   |
|---|------------------------------------|---------------------------|---|
|   | Management of timber resources     | Baseline and alternatives | <p>Carrying out an inventory that includes timber species and their estimated quantity in the territory</p> <p>For the replacement of exploited timber resources, reforestation with native and endemic species is essential.</p> <p>The integral use of wood, not only obtaining boards, planks, etc., but also its residues: leaves and branches can be used in fertilizers and the remaining parts of the trunk for handicraft activities</p> <p>Use and planting of bamboo species for the production of handicrafts, food purposes, trails, furniture, buildings</p> |
| Management of timber and non-timber trees | Management of non-timber resources | For agricultural purposes | <p>Supply to the production chain in fairs, markets and online platforms</p> <p>Establishment of a fair price according to the reality of the demand</p> <p>To reach the consumer with the products directly to avoid intermediaries in the commercialization that increase the prices</p> <p>Inclusion in like-minded producer associations that promote fair trade and organic production</p> <p>Identification of species with medicinal value</p>   |

Article  
**Estimation of Current and Future Suitable Areas for *Tapirus pinchaque* in Ecuador**

Carlos Mestanza-Ramón <sup>1,2,\*</sup>, Robinson J. Herrera Feijoo <sup>3,\*</sup>, Cristhian Chicaiza-Ortiz <sup>3,4,5,6,7</sup>, Isabel Domínguez Gaibor <sup>8,9</sup> and Rubén G. Mateo <sup>10,11</sup>

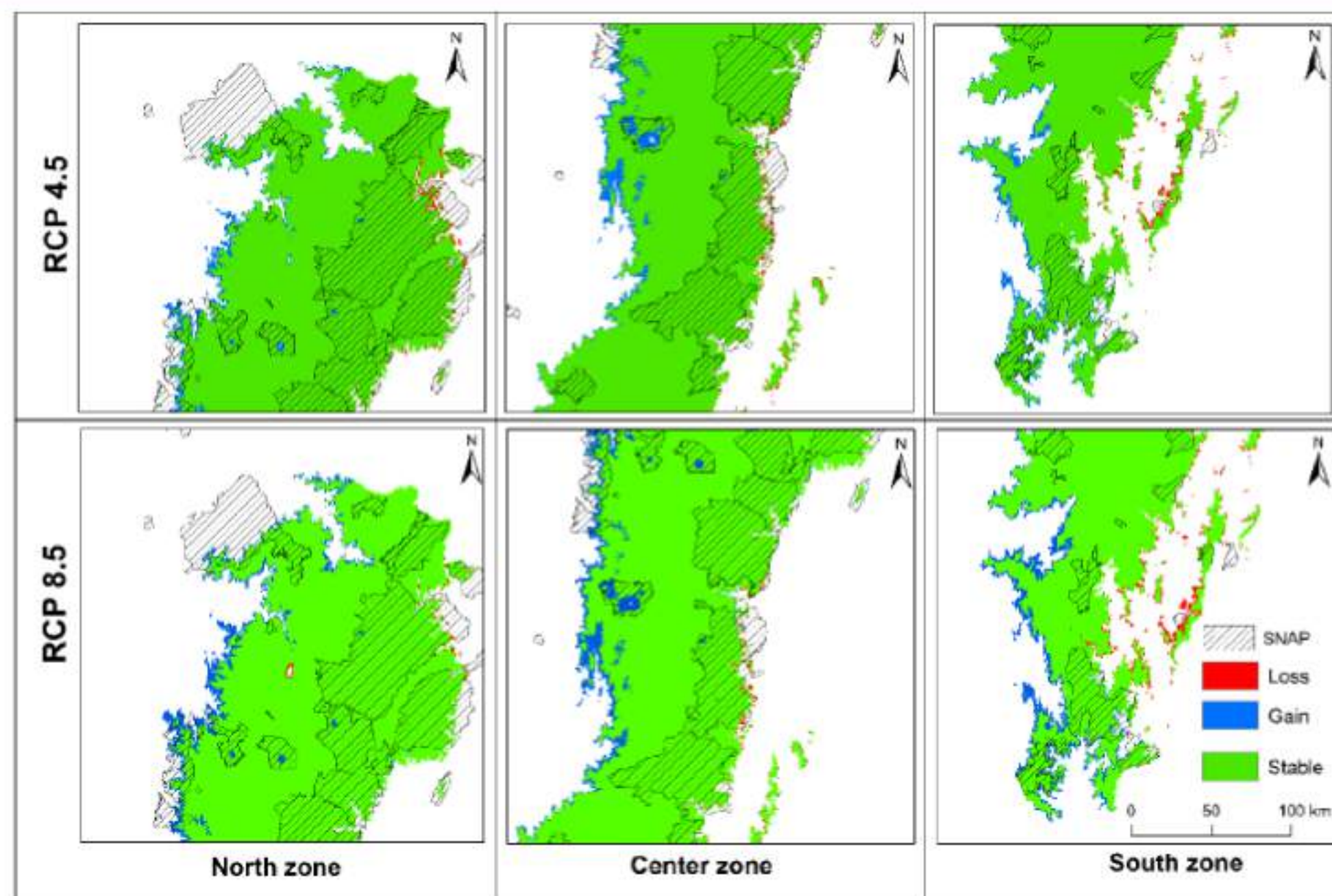
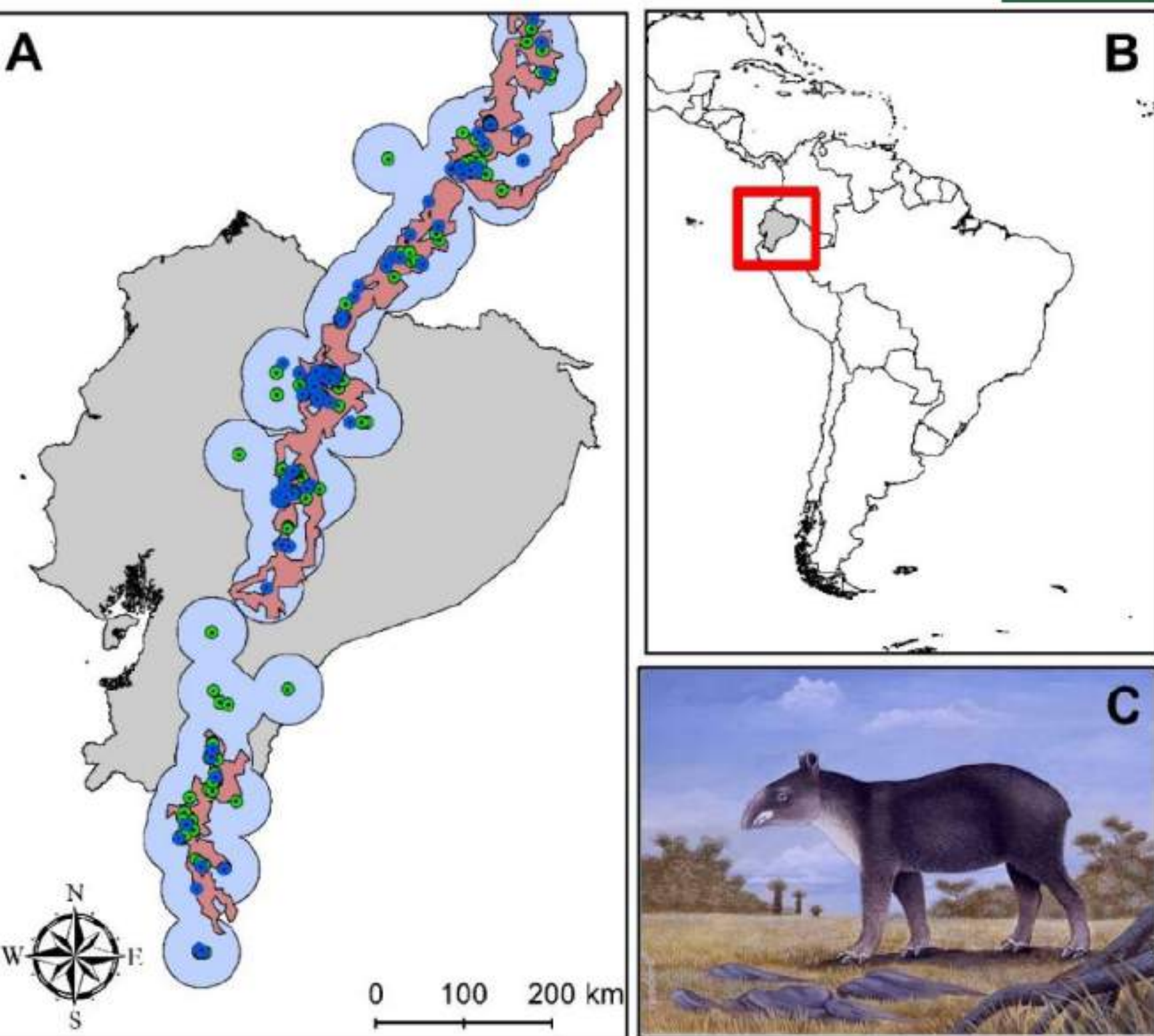


Figure 2. Reported changes in areas suitable for *T. pinchaque* distribution under climate change scenarios.

Figure 1. (A) Study area, represented in three zones: north, center, and south; (B) known distribution area of *T. pinchaque* in the South American Andean region; (C) infographic of the species; (D) Map legend.

## Factibilidad para implementar una hostería ecológica en el cantón Archidona, Napo-Ecuador

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<sup>2</sup> Universidad Regional Amazónica Ikam, Facultad Ciencias de la Vida;

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**Resumen:** El turismo ecológico nace a partir de las nuevas tendencias y del interés de visita a las áreas naturales, poco intervenidas y con la presencia de una alta biodiversidad (natural y cultural), cuyas actividades se enmarquen en la sostenibilidad. En este sentido, el turismo ecológico constituye una fuente de dinamización económica y desarrollo local sostenible, en las últimas décadas se ha mostrado como una actividad con potencial para diversificar la estructura económica, cuidar el ambiente y generar puestos de trabajo. En este contexto, se plantea un estudio para evaluar la factibilidad de implementación de una hostería ecológica en la parroquia San Pablo de Ushpayacu, en la provincia de Napo. La metodología empleada inició con el análisis de la perspectiva de la población local, así como las necesidades de la demanda potencial. Los resultados evidencian que existe la predisposición de colaborar y participar en la prestación y consumo de servicios de alojamiento, alimentación y tours organizados por los sitios aledaños, identificados con potencial turístico. La propuesta incluye el análisis del impacto ambiental en la matriz de Leopold, así como el diseño arquitectónico, además del análisis técnico, legal y financiero, mismos que muestran la factibilidad de ejecución en el corto plazo, puesto que el impacto ambiental a generarse es mínimo y se pueden establecer medidas de mitigación para contrarrestar sus efectos.

**Palabras claves:** Alojamiento; estudio; desarrollo turístico; factibilidad.

### Feasibility of implementing an ecological inn in the Archidona canton, Napo-Ecuador

**Abstract:** Ecotourism was born from the new trends and interest in visiting natural areas, with little intervention and the presence of a high biodiversity (natural and cultural), whose activities are framed in sustainability. In this sense, ecotourism is a source of economic dynamization and sustainable local development, and in recent decades it has been shown as an activity with the potential to diversify the economic structure, care for the environment and generate jobs. In this context, a study is proposed to evaluate the feasibility of implementing an ecological lodge in the parish of San Pablo de Ushpayacu, in the province of Napo. The methodology employed began with the analysis of the perspective of the Green World Journal /Vol 05/ Issue 01/007/ January - April 2022 /[www.greenworldjournal.com](http://www.greenworldjournal.com)



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Figura 3. Fachadas de cabañas, hostería ecológica



Figura 4. Fachada del restaurante





# Available biomass resources in the Amazon region

"Revaluation of the Amazonian cocoa husk through the modernization of processes to obtain kraft paper for a clean production of systematized circular economy".



Cocoa pod

(a)



Cocoa pod husk

(b)



Crushed cocoa pod husk

(c)





# Hidroeléctrica y Relleno sanitario - Baños



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