Bio-cord as an Ecotechnological Wastewater Treatment for Productive and Attractive Urban Open Spaces

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Abstract: Bandung, has a great variety urban spaces within the city as urban fabric. Rapid urban population leads to a rapid destruction. Therefore, there is an urgent need to optimize the utilization of existing open spaces become more productive and attractive. This study attempts to examine and identify the potential and capability of open space along Babakan Irigasi stream zones to optimize the spatial around neighbourhood. The hypothesis is that by using Bio-Cord as wastewater treatment will develop sustainable characteristics and reshaping urban spaces, it will help to be productive and liveable spaces. The paper presents the field data contains all open spaces along Babakan Irigasi, and the variable aspects that optimize open spaces that consists of quality, functional, and ecological-environmental aspects. Then, analyse the design strategies as the impact of the wastewater treatment along the stream with Bio-Cord technology to achieve sustainable urban development, and find values of productive and attractive urban open spaces. The Bio-Cord as an ecotechnological treatment play a key role in the environmental design and sustainable development of the urban structure. This study showed that productive and attractive open spaces are great importance for urban spatial structure that can support sustainability.

1 INTRODUCTION

Bandung, the capital city of West Java province has a great variety urban space. One of the typical urban open spaces is Babakan Irigasi area. Babakan Irigasi is located in two districts Astana Anyar and Bojongloa Kaler. It is uniques because open spaces along Babakan Irigasi area flowed by two rivers, Citepus River and Ciroyom River. The specific area of Babakan Irigasi that was studied is the segment between Pagarasih road and Terusan Pasir Koja road. Those rivers across along the research object area approximately 400 meters in length. Like other riverside settlements area, all building orientation is following the stream's shape characteristics.

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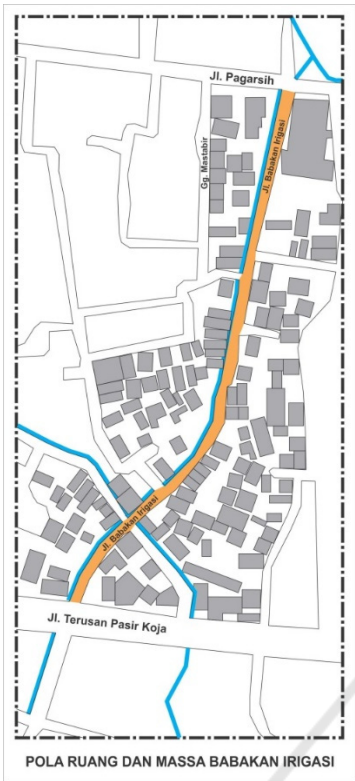

Figure 1: Urban Fabric Pattern Along Babakan Irigasi Segment Pagarsih-Terusan Pasir Koja.

The utilization, protection, creation, and development of urban open spaces is one of the key elements to achieve sustainable urban development. But the rapid urban population and the socio-cultural of the communities sometimes lead to a rapid destruction, also has caused a decreased number of the quality of open spaces. Therefore, there is an urgent need to optimize the utilization of existing open spaces become more productive and attractive.

Figure 2: Open Space an Circulation Along Babakan Irigasi Stream.

Could the urban open spaces at Babakan Irigasi be optimize to become a productive and attractive open space within the city of Bandung to help it become sustainable? This study attempts to examine and identify the potential and capability of open space along Babakan Irigasi stream zone to make use the spatial around their neighbourhood. What are the functions of space created and activities that can be created as urban open spaces with the characteristic of riverside area.

This study also beneficial to safeguard the future of sustainable architecture in the city, to improve the quality of urban areas especially the neighbourhoods along Babakan Irigasi, to make urban areas more attractive, productive and to enhance the well-being of local people. The hypothesis is that by using Bio-Cord technology as wastewater treatement will optimize the sustainable characteristics on existing or reshaping urban open spaces, it will help it to be productive and liveable.

2 METHODS (AND MATERIALS)

The structure of the paper presents the data about the concept and typology of sustainable urban open spaces, field data of the research object, that is open spaces along Babakan Irigasi stream, and the variable aspect that optimize urban open spaces that consists of quality aspects, functional aspects, and ecological-environmental aspects. The second part, to analyze the design strategies of the utilization, protection, creation, and development of the areas as the impact of the waterwaste treatment along the stream with Bio-Cord technology. Whether this technology is an innovative solution for effective design urban spaces to achieve sustainable urban development. And the last part of this paper is to find productive value and attractive value of urban open spaces which link social, cultural, environmental and economic dimensions of sustainability.

2.1 Urban Open Space

Urban open space is one of important element that included in eight elements of urban designs (Shirvani, 1985, p. 5-49). Open space has so many benefits for human and environment because it can be used as an alternative for social interaction place and as rain absorption land besides its beauty.

There are two types of open space which are space that has fixed function such as swimming pool, basketball court, etc. and space that has adaptive function like a court with public seating area and

vegetation so people can do sports, playing with children or picnic. Furthermore, open space has its qualification based on Urban Open Space (Francis, 2003, p. 6-7)

Table 1: Typology of Urban Open Spaces.

Type	Subtype
Public Parks: the subtypes are based on its size and location	Central parks
	Downtown parks
	Neighbourhood parks
	Mini parks
Squares and Plazas	Central square
Markets	Farmers markets
	Atrium
	Downtown shopping centre
Streets	Pedestrian sidewalks
	Bicycle path
	Traffic restricted street
Playground	Playground
	School playground
Waterfront	Riverfront
	Lakefront
	Piers

An open space can be created by placing building mass or objects that surround it. It also called as positive space because it has contribution for human and environment.

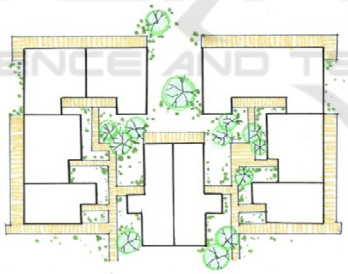

Figure 3: Open Space and Buildings Type 1.

Figure 4: Open Space and Buildings Type 2.

As an architect, we have to aware of negative spaces that occur when there are spaces that don't have specific function and scattered among building mass or objects.

2.2 Sustainable Urban Development

Sustainable urban development is meant to enrich the lives of the society, that's why planners have to know how to engage with the complexity of community life. Sustainable development is something that comes from within communities. Development is a process, it needs to be defined in terms of social change and what is changing that brings about a significant and patterned shift in the technologies, techniques, infrastructure, and/or associated life-forms of a place or people. Significant changes include the changing forms of urbanization such as urban sprawl and the decentralization of non-residential functions, for example retail parks, massively increased levels of commuting between urban and rural areas, the development of communication and transport technologies. Sustainability is usually defined in terms of being able to carry on, endure, or have a future. (James, 2015, p. 21).

Sustainable urban development is a multi-layered concept. It synthesizes land development and nature preservation. It also refers to the capacity of nature to support its activities, the vitality of a city as a complex system, and the quality of life of its inhabitants. Sustainable urban development covers many fields of activity such as environmental protection, human development, and inhabitant wellbeing. (Tang and Lee, 2016, p. 10)

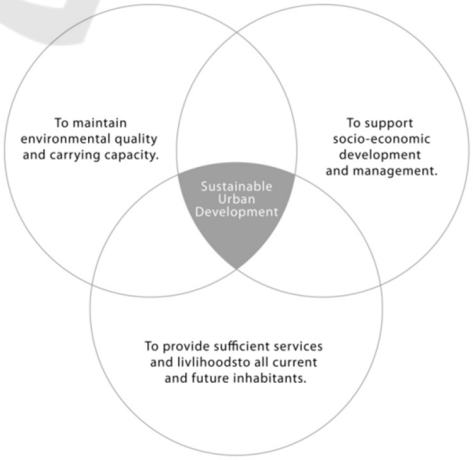

Figure 5: Three Aspects Sustainable Urban Development.

Furthermore, related with human settlements context, there are some aspects in developing a sustainable community such as:
• Sustainable land use
• Social development
• Population
• Environmentally sustainable, healthy and liveable
• Sustainable energy use
• Sustainable transport and communication systems
• Conservation and rehabilitation of the historical and cultural heritage
• Improving urban economies
• Balance development in rural regions
• Disaster prevention, mitigation and preparedness, and post-disaster rehabilitation capabilities
(Lundqvist, 2007, p. 11-12)

Succinctly, public space design aims sustainibilty in 5 aspects, there are :

1. CommunityWelfare
Community welfare as basic motivation in creating and developing public space. Community provides movement path or circulation, communication centre and a place to feel free and relax.
2. Visual Enhancement
A public space in a city will increase its visual quality by being more human, harmony and good looking.
3. Environmental Enhancement
Greenery in open public space can give a boost in aesthetic value and provides better air quality in the middle of air pollution.
4. Economic Development
Economic development as a general purpose in creating and developing an open public space.
5. Image Enhancement
Image enhancement is an abstract goal that isn't clearly stated in creating an open public space but it has to be achieved.
(Carr, S,Et All., 1992, p.420)

2.3 Urban Farming as Productive Urban Open Space

Massive development in urban areas has led to the displacement of green open spaces. The loss of green open space affects the stability of environmental ecosystems. It also increases pollution, which is bad for the health of urban communities. The concept of urban farming then offers a solution by creating green open land in the midst of dense urban buildings. Urban farming can manage polluted urban areas into a comfortable and healthy environment to live in (cybex.pertanian.go.id).

What can become urban farming land is: a. Private land, such as home yards, terraces, walls, fences, gutters, and rooftop. b. Common land, such as abandoned land, walls of alleys, riverbanks or over rivers. Limited land, which is often seen as an obstacle, can be overcome by applying various cultivation technologies. From the simplest things such as pots and polybags, also using waste materials such as noodle containers, paint containers, and used buckets. The vertical planting is called the verticulture system. Containers used waste mineral bottles, or from pipes (www.dekoruma.com.) In the market, there is also a media that resembles a pocket that can be hung on the wall. (www.tokopedia.com/find/wall-planter-bag).

Difficult techniques are called hydroponic techniques and aquaponics techniques (Pudjiastuti, 2017, p. iii). Cultivation consists of vegetables, herbs, fruit, and ornamental plants. The type of plant is adapted to the container. Small pots, verticulture, and hydroponics are usually applied to light, short-rooted, and short-lived plants (Pudjiastuti, p 3). Combined cultivation is called the aquaponic technique, for example, cultivating vegetables with fish or fruit with fish (Pudjiastuti, p. 99). Law Number 26 of 2007 concerning Spatial Planning Article 29 states that the proportion of Green Open Space in urban areas is at least 30% of the total area (Nurmala, 2019, p. 1) The city of Bandung has a composition and proportion of green open space area of only 12.20% (Nurmala, p. 3). The city of Bandung supplies 98% of its foodstuffs from other cities. The limited land and food availability are anticipated by the Bandung City Government with the SAE (Healthy, Natural and Economical Yard and Kangpisman (Reduce, Separate and Utilize) Waste Program (buruansae.bandung.go.id). It takes creative thinking from the community and universities to enrich urban programs. farming in the fields of economics, environmental aesthetics, creative activities, and citizen recreation.

2.4 Bio-cord Technology

As cities continue to grow, they also generate lots amount of solid and liquid waste. In some developing countries, the waste is being disposed to the river that cause river water pollution. Since 2017, Indonesia adopted a technology called bio-cord in its wastewater treatment. This technology help to increase water quality up to 50% depending on the pollution (Sugara, 2017:17).

The basic principle of Bio-Cord technology is using synthetic fibre (Bio-Cord) that become a host

for microbial. This microbial can break down the polluted substance inside the water and change it into a better water.

Figure 6: Bio-Cord Installation at Cikapayang River.

About the installation, there are several requirements, such as:

1. Water body length: 100 metre
2. Water body width: 2 metre
3. Number of Bio-Cord lines: 20

3 RESULTS AND DISCUSSION

Before the installation of Bio-Cord technology on Babakan Irigasi stream is negative urban spaces, which non-productive and not atrractive area. Urban settlement around the riverside settlement looks slum with black water as waste water. The condition of surrounding is also passive, no public activities that creates livable spaces and places.

Figure 7: The Condition of Babakan Irigasi before Bio-Cord Installation.

Poorly maintained environmental conditions along Babakan Irigasi caused unpleasant odors and bad views. Wastewater treatment with Bio-cord technology aims to process water purification, so that the river water becomes clear and odorless. This This condition will make benefit for all, both local government and local residents where the riverside conservation where this kind of efforts will have the potential power to become a productive and attractive open spaces that increase the economy of the local community.

Figure 8: Bio-Cord Installation at Babakan Irigasi.

In 2020 The Bandung city government get PEMERINTAH Kota (Pemkot) Bandung obtain financial assistance from PT Bank Rakyat Indonesia Persero Tbk for riverside conservation program at RW 04 Babakan Irigasi. Since that time of Bio-Cord technology was installed at Babakan irigasi area. This program brings the potential and capability of urban open space to become productive and attractive area.

Below is some functions of spaces and some activities that can be created as urban open spaces with the characteristic of riverside area.

3.1 Productive Public Open Spaces

Since the supply of clean water from the river due to installation of Bio-Cord technology, local community creates various productive spaces to their activities. It is said to be productive because these activity spaces facilitate activities that can have positive impacts in terms of quality aspects, functional aspect, and ecological-environmental aspects. Moreover, it is also improving socio-economic welfare for local community.

The quality aspects of urban open spaces deal mostly with:

- The suitability and quality of site structure
- Design of urban green spaces with regard to their importance and functions
- Site condition quality
- Quality aspects associated with natural and landscape features, historic and cultural values and qualities that should be preserved or emphasised.

The functional aspects of urban open spaces are linked with:

- Accessibility and use of open spaces
- Connectivity of public spaces

Ecological and environmental aspects deal with:
- Biodiversity and ecological value
- Natural corridors
- Urban climate; and
- Other environmental aspects that are important for human well-being and health.

As for the spaces created are vegetables garden, hydroponic garden, vertical flower garden, fish pond, compost plant, clean water reservoir (ground tank and upper tank), cafeteria, retail, vertical garden along the circulation area both edible and aesthetic plants, etc.

Figure 9: Community Vegetables Garden.

Figure 10: Community Hydroponic Garden.

Figure 11: Community Fish Pond.

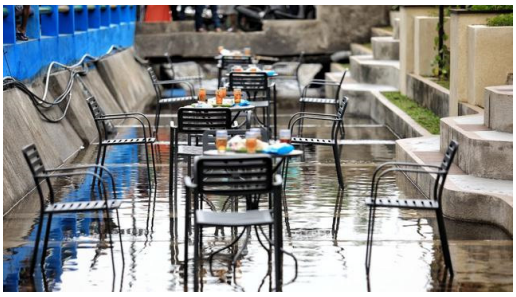

Figure 12: Café Walungan.

Figure 13: Food Counter at The Bridge.

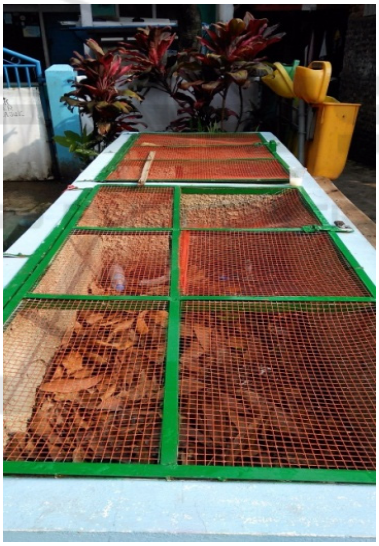

Figure 14: Community Compost Plant.

Figure 15: Clean Water Ground Tank Reservoir.

Figure 16: Clean Water Upper Tank Reservoir.

3.2 Attractive Public Open Spaces

Besides the productive spaces that was created. Installation of Bio-Cord technology also creates various attractive spaces. As for the attractive spaces referred to in the context of architectural design, includes facade design, composition of open space and building mass, outdoor materials, street furniture, and new attractive functions of space.

As for the spaces created at Babakan Irigasi area are natural swimming pool, relaxing garden, children playground, colourful bulding façade, semi-amphitheatre, selfie spot, etc.

Figure 17: Children are Playing and Swimming.

Figure 18: Public Relaxing Garden.

Figure 19: Community Children Playground.

Figure 20: Public Relaxing Garden with Roof.

Figure 21: Attractive House Fasade.

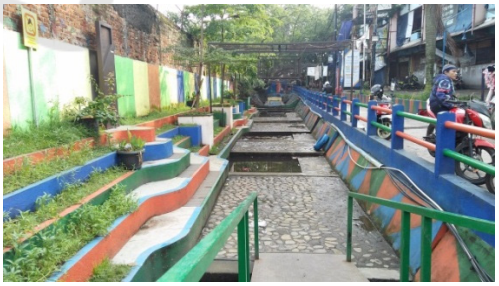

Figure 22: Mini Semi-Amphitheatre

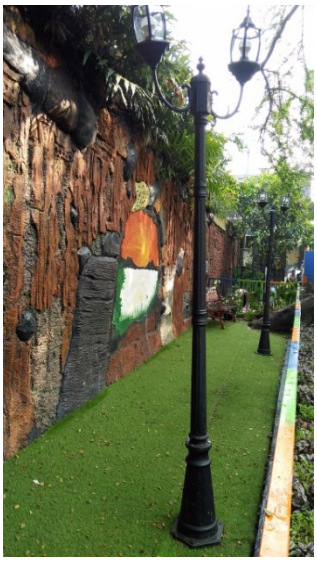

Figure 23: Selfie Spot.

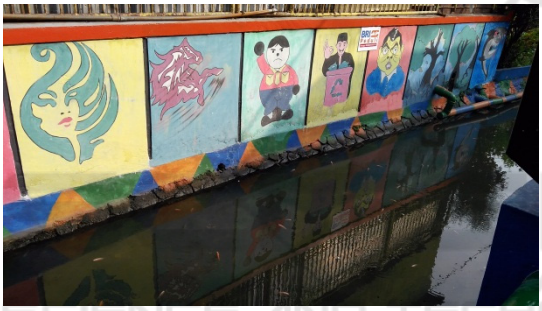

Figure 24: Attractive Spaces Retaining Wall with Mural Wall.

3.3 Productive Value and Attractive Value of Urban Open Spaces as Dimensions of Sustainibilty

We measure productive value and attractive value of urban open spaces which link to public space design that aims sustainibilty consists of these variable aspects : Community Welfare, Visual Enhancement,, Environmental Enhancement, Economic Development, Economic Development and Image Enhancement.

We identified various type of public spaces along Babakan Irigasi and analysed all the supporting variables to find how does the Bio-Cord Technology optimize urban open spaces along Babakan Irigasi.

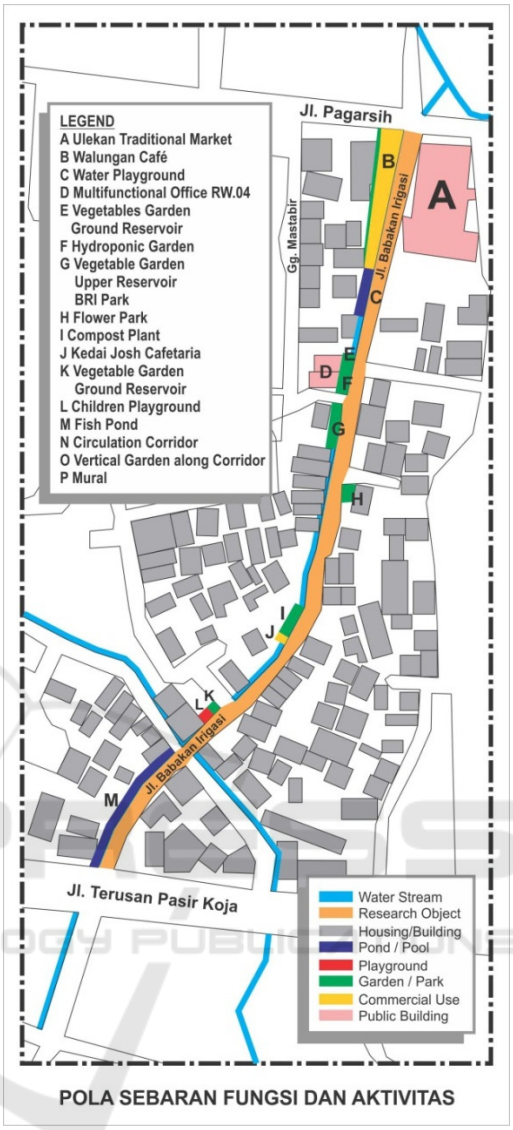

Figure 25: Productive and Attractive Spaces at Babakan Irigasi Riverside Settlement.

1. Analysis of Community Welfare Aspect

This table shows how community welfare as basic motivation in creating and developing public space. Community provides movement paths or circulation, communication centre and a place to feel free and relax.

Table 2: Aspects of Community Welfare in Dimensions of Sustainibility.

Productive Public Spaces at Babakan Irigasi	LEGEND	Community Welfare		
		Movement/ Circulation	Communication	Relax &Free
Circulation Corridor	N	√	-	-
Vegetables Garden	E	-	-	-
Hydroponic Garden	F	-	-	-
Vertical Garden along the Circulation Corridor	O	√	-	√
Fish Pond	M	-	√	√
Compost Plant	I	-	-	-
Clean Water Reservoir (ground tank)	E	-	-	-
Clean Water Reservoir (upper tank)	G	-	-	-
Cafeteria	B	-	√	√
Retail Kiosk	J	-	√	√
Flower Park	H	-	-	√
Attractive Public Spaces at Babakan Irigasi	**LEGEND**	**Movement/ Circulation**	**Communication**	**Relax &Free**
Water Playground	C	√	√	√
Colourful building façade with Mural	P	√	-	√
Outdoor Semi-Amphitheatre	B	-	√	√
Selfie Spot	B	-	√	√
Relaxing Garden	G	-	√	√
Children Playground	L	-	√	√

Vegetables Garden, Hydroponic Garden, Compost Plant, Clean Water Reservoir are urban public open spaces that are not fulfilled in community welfare aspects.

2. Analysis of Visual Enhancement Aspect

A public space in a city will increase its visual quality by being more human, harmony and good looking.

Table 3: Aspects of Visual Enhancement in Dimensions of Sustainibility.

Productive Public Spaces at Babakan Irigasi	LEGEND	Visual Enhancement		
		Humanist	Harmony	Good Looking
Circulation Corridor	N	√	√	√
Vegetables Garden	E	√	√	√
Hydroponic Garden	F	√	√	√
Vertical Garden along the Circulation Corridor	O	√	√	√
Fish Pond	M	√	√	√
Compost Plant	I	-	-	-
Clean Water Reservoir (ground tank)	E	-	-	-
Clean Water Reservoir (upper tank)	G	-	-	-
Cafeteria	B	√	√	√
Retail Kiosk	J	√	-	-
Flower Park	H	√	√	√
Attractive Public Spaces at Babakan Irigasi	**LEGEND**	**Humanist**	**Harmony**	**Good Looking**
Water Playground	C	√	√	√
Colourful building façade with Mural	P	√	√	√
Outdoor Semi-Amphitheatre	B	√	√	√
Selfie Spot	B	√	√	√
Relaxing Garden	G	√	√	√
Children Playground	L	√	√	√

There are only two open spaces that are not fulfilled according to visual enhancement variables. They are Compost Plant and Clean Water Reservoir.

3. Analysis of Environmental Enhancement Aspect

Greenery in open public space can give a boost in aesthetic value and provides better air quality in the middle of air pollution.

Table 4: Aspects of Environmental Enhancement in Dimensions of Sustainibility.

Productive Public Spaces at Babakan Irigasi	LEGEND	Environmental Enhancement	
		City Lungs	Greenery
Circulation Corridor	N	√	-
Vegetables Garden	E	√	√
Hydroponic Garden	F	√	√
Vertical Garden along the Circulation Corridor	O	√	√
Fish Pond	M	-	√
Compost Plant	I	-	√
Clean Water Reservoir (ground tank)	E	-	√
Clean Water Reservoir (upper tank)	G	-	√
Cafeteria	B	-	-
Retail Kiosk	J	-	-
Flower Park	H	-	√
Attractive Public Spaces at Babakan Irigasi	**LEGEND**	**City Lungs**	**Greenery**
Water Playground	C	-	√
Colourful building façade with Mural	P	-	-
Outdoor Semi-Amphitheatre	B	-	-
Selfie Spot	B	-	-
Relaxing Garden	G	√	√
Children Playground	L	-	-

There are some public spaces that are not fulfilled to these variables : Cafeteria, Retail Kiosk, Colourful Building with Mural Facade, Outdoor Semi-Amphitheatre, Selfie Spot, and Children Playground.

4. Analysis of Economic Development Aspect

Economic development as a general purpose in creating and developing an open public space.

Table 5: Aspects of Economic Development in Dimensions of Sustainibility.

Productive Public Spaces at Babakan Irigasi	LEGEND	Economic Development
		Economic Value
Circulation Corridor	N	-
Vegetables Garden	E	√
Hydroponic Garden	F	√
Vertical Garden along the Circulation Corridor	O	-
Fish Pond	M	-
Compost Plant	I	-
Clean Water Reservoir (ground tank)	E	-
Clean Water Reservoir (upper tank)	G	-
Cafeteria	B	√
Retail Kiosk	J	√
Flower Park	H	-
Attractive Public Spaces at Babakan Irigasi	**LEGEND**	**Economic Value**
Water Playground	C	-
Colourful building façade with Mural	P	-
Outdoor Semi-Amphitheatre	B	√
Selfie Spot	B	-
Relaxing Garden	G	-
Children Playground	L	-

According to Economic Development Aspect there are five public spaces have the economical value that increasing economy of the community, following Circulation Corridor, Hydroponic Garden, Cafeteria, Retail Kiosk, Outdoor Semi-Amphitheatre.

5. Analysis of Image Enhancement Aspect

Image enhancement is an abstract goal that isn't clearly stated in creating an open public space but it has to be achieved.

Table 6: Aspects of Image Enhancement in Dimensions of Sustainibility.

Productive Public Spaces at Babakan Irigasi	LEGEND	Image Enhancement	
		In Order	Cleanliness
Circulation Corridor	N	√	√
Vegetables Garden	E	√	√
Hydroponic garden	F	√	√
Vertical Garden along the Circulation Corridor	O	√	√
Fish Pond	M	√	√
Compost Plant	I	√	√
Clean Water Reservoir (ground tank)	E	√	√
Clean Water Reservoir (upper tank)	G	√	√
Cafeteria	B	√	√
Retail Kiosk	J	√	√
Aesthetic Plants Garden	H	√	√
Attractive Public Spaces at Babakan Irigasi	**LEGEND**	**In Order**	**Cleanliness**
Water Playground	C	√	√
Colourful building façade with Mural	P	√	√
Outdoor Semi-Amphitheatre	B	√	√
Selfie Spot	B	√	√
Relaxing Garden	G	√	√
Children Playground	L	√	√

This table shows how effective Bio-Cord Technology as the trigger which creating urban open spaces that all the functions of urban open spaces became tidy, in order and clean. These image is totally different like other urban open spaces along the stream or river we used to see.

4 CONCLUSIONS

The Bio-Cord Technology that installed at Babakan Irigasi area as an ecotechnological treatment play a key role in the environmental design and sustainable development of the urban structure of the city settlement. This study showed that productive and attractive open spaces are of great importance for urban spatial structure that can support sustainability.

Table 7: Aspects of Economic Development in Dimensions of Sustainibility.

Dimension of Sustainibility	Fulfilled	Not Fulfilled
Community Welfare	70,6%	29,4%
Visual Enhancement	82,3%	17,7%
Environmental Enhancement	64,7%	35,3%
Economic Development	29,4%	70,6%
Image Enhancement	100%	0%

This table shows that the result of functional mapping of urban open spaces that created as the impact of Bio-Cord Technology analyze by five aspects as dimensions of sustainibilty,

Image Enhancement is the most fulfilled aspect where all public spaces that created were fulfilled 100%. Visual Enhancement is also fulfilled 82,3% that means urban open spaces that were created are humanist, harmony and good looking. While the community welfare aspects show that urban public were fulfilled 70,6% that contains of movement, communication, relaxing&free activity as the variables. The environmental enhancement aspects show the number of 64,7% where urban public open spaces enabled as the city lung and greenery elements which means environmental friendly. Meanwhile economical development aspects only shows 29,4% that are fulfilled, where only a few spaces have the economical value.

This kind transformation of waste land to a productive and open space is one of the city urban renewal plan.

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This paper is part of our devotion to the riverside urban community which which requires spatial planning and visual design that can make productive and attractive to increase community welfare. All the authors also express the gratitude to the community at RW 04 Babakan Irigasi Bandung for the filed data to complete this paper.

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