Sustainable rural development and water resources management on a hillside SEPLS: A case study in Gonglaoping community, Taichung, Taiwan

Chen-Fa Wu [1], Chen Yang Lee [2], Chen-Chuan Huang [3] Chih-Cheng Weng [3], Ming Cheng Chen [2], Choa-Hung Chang [3], Szu-Hung Chen [4*], Yi-Ting Zhang [1], and Kuan Chuan Lu[5]

[1] **Department of Horticulture of National Chung Hsing University (NCHU), No.145, Xinda Road, South District, Taichung City, Taiwan 402, ROC**

[2] **Soil and Water Conservation Bureau (SWCB), No.6, Guanghua Road, Nantou City, Taiwan 540, ROC**

[3] **SWCB Taichung Branch, No.22, Yangming Street, Fengyuan District, Taichung City, Taiwan 420, ROC**

[4] **International Master Program of Agriculture, NCHU, No.145, Xinda Road, South District, Taichung City, Taiwan 402, ROC**

[5] **Gonglaoping Industrial Development Association (GIDA), No. 8, Pingding Lane, Shuiyuan Rd, Fengyuan District, Taichung City, Taiwan, 420, ROC**

Szu-Hung Chen (vickey@dragon.nchu.edu.tw)

Abstract

Gonglaoping Community is located at the central-western of Taiwan, with approx.700 residents. The main landscape contains 100-ha farmlands (40%) and an 80-ha slopeland with abundant ecological resources. Locals rely on the Han River system and seasonal rainfall regarding water supply and irrigation. Uneven rainfall pattern becomes more severe due to impacts of climate change. Surrounding natural forestry lands provide important ecosystem services, including wildlife habitats, water conservation and so on. However, parts of human production landscapes are overlapping with critical wildlife habitats of low elevation mountains that could threaten biodiversity conservation. Therefore, it is essential to come up a strategic plan that can keep equilibrium between human activities and biodiversity conservation.

Recently, governmental authorities of Taiwan (SWCB) are taking the lead to promote the SDGs and implement practical measures to rehabilitate agricultural landscapes and its ecosystem services. Besides that, the community has insisted to pass down the tradition that emphasizes in harmony with nature. Its traditional heritage not only strengthens local trust but aid them to establish a resilient system. According to all, locals actively seek a holistic approach to their goals by: (1) restoring SEPLS with eco-friendly farming; (2) establishing water resources management strategy based on mutual trust; (3) allocating water resources through solar power system; (4)increasing the slope stability by dry masonry embankment construction, a low-impact and with traditional wisdom practice; (5) improving community resilience after establishing water reuse system and restore SEPLS; (6)developing products/services for a sustainable economy.

With hard work of the Gonglaoping Community and cross-sector collaboration with multiple stakeholders (SWCB, NCHU, local groups), evident achievements include: (1)

resolving conflicts of water use during dry seasons by increasing water storage capacity and reducing groundwater consumption; (2) restoring traditional masonry SEPLS and strengthening biodiversity conservation; (3) empowering, enhancing and sustaining local operation through leadership of a community-led NGO, the Gonglaoping Industrial Development Association; (4) enhancing benefits of green industries: the new economic and ecological values of organic industries.

To achieve sustainability of SEPLs will require applications of a holistic approach and take affairs based on cross-sector collaboration (community-government-university). Our achievements demonstrate a practical, effective framework to government authorities, policy makers and other stakeholders in terms of maintaining the integrity of ecosystem services; then boosting success of actions to conserve biodiversity. With the final outcome of promoting a vision of co-prosperity, it is a solid case showing win-win strategy for both human and farmland ecosystem in hillside areas.

Keywords: agricultural landscape; eco-friendly farming; water resources conservation; dry stone masonry; sustainable rural development

1. Introduction

The Gonglaoping, a hillside rural community of Fengyuan District, is situated in the central-western part of Taiwan, with approximate 700 residents. The main landscape is a terraced terrain with a total area of 250 ha, which contains approximate 100-ha farmlands, and an 80-ha foothills with abundant ecological resources. The entire community is also located within the Han River upstream watershed.

River terraces in this area are formed by the Toukoshan Formation in geological settings. It originated from an alluvial plain and then was raised graduated to current status, causing by orogenesis. The main topography is relatively flat with a mean elevation of 450 meters. Thus, most residents settle in flatter areas and grow orchards at slope hillsides. Soil is developed from the Cholam Formation and lateritic river sediments. Cholam Formation contains the sandstone, mudstone and shale while river sediments are consisted of red clay, gravel, sand, and clay sediments. Both formations present good permeability, in other words, low water retention capacity.

Mean annual temperature of Gonglaoping is 21.6 ºC, and the climate here shows distinct seasons with uneven rainfall patterns. The wet season starts from April to September with mean monthly precipitation of 268 mm while the dry season is from October to March with less rainfall (about 42 mm). In recent years, drought occurs more frequently due to climate change impacts. To sum up, the terrace topography, low water detention soil and the climate with distinct seasonal precipitation lead local production landscapes vulnerable to drought.

County	Chinese Taipei
Region	East Asia
Province	Taichung City
District	Fengyuan District
Size of geographic area	250 Hectares
Number of direct beneficiaries	685 (2018 census)
Geographic coordinate (Longitude/latitude)	24°15'33.2"N 120°45'53.5"E

Figure 1. Map of the county a case study region. From left to upper right, relative locations of Fengyuan District and Taichung City in Taiwan (#1-3).For the lower right section (#4), location of Gonglaoping Community within the Han River upstream watershed (area marked in yellow-dashed line).

Since 200 years ago, Shiu Gong as a pioneer arrived here to explore the land and started cultivation. Afterward, the settlement began to form on the plain near the headstream of Han River. The land near the headstream did receive sufficient water supply; however, the terrain has slope ranging from 32° to 52°and became hard to further expand agriculture activities. In order to stabilizing the hillside soil, the ancestors collected available materials (e.g., stone, pebbles) on or near the site for construction. The stone piled up retaining walls and formed dry masonry embankments in the valley, which became an iconic, Socio-ecological Production Landscape (SEPL).

Before 1940s, locals mainly grew food crops, such as sugar cane, rice, and potatoes for the purpose of food security. Since 1945, Taiwan's GDP started increased and economics developed quickly, food crops were no longer competitive. Also the micro-climate in Gonglaoping is quite suitable for the growth of fruit trees. Thus, farmers began to converting to orchards cultivation such as citrus, persimmon, and lychee. Persimmon growing on hillside farmlands is a typical temperate fruit tree. Persimmon orchards show different color themes by seasons. In spring, a cluster of green leaves grows on the thin branches. In summer, trees start fruiting. In autumn, persimmon gradually matures, and fruit itself turn red. When winter comes, the hibernating period of persimmon trees initiate, and colour of leaf turns from green to red or golden yellow. The whole hillside shows a unique production landscape mosaicked by dry masonry wall and vibrant red-golden-yellow colour.

Figure 2. Overview of Persimmon orchard landscapes

In 1990, farmers in Fengyuan District established the 5th Citrus Agricultural Production and Marketing Group. The group often held training workshops or forums to exchange experiences and learn from each other. In order to reduce the production cost, members set up a joint venture agreement, particularly, to purchase the citrus cleaning and classifying machine, refractometers (Brix meters)and other instruments. They invited online marketing experts to teach members how to operate ecommerce. In this way, farmers would become capable to make direct sales online, then reduce the cost of agency sales, access consumers' demands and feedbacks effectively, and boost up profits.

In 2009, the Citrus Agricultural Production and Marketing Group of Fengyuan District won the national top ten prize awarded by COA, Taiwan. Because of the high-quality fruit and the brand

name recognition, the sale values and price greatly increases substantially, leading to a major income boost for locals.

The community also commits to preserve and pass down tradition culture that emphasizes in harmony with nature. Its embedded culture and belief not only strengthen the sense of coherence but also aid them to build up a community operating system with resilience, in particular, beneficial to achieve goals of sustainable rural development.

Considering all facing challenges, it is quite essential to develop a holistic approach that operate based on local mutual trust and can maintain equilibrium among agricultural actives, water resources management, biodiversity conservation, local economic development, life quality and so on.

2. Description of Activities

The community actively seeks a holistic approach to achieve rural sustainable development and maintain the SEPL by:

(1) restoring SEPLS with eco-friendly farming;
(2) establishing water resources management strategy based on local mutual trust;
(3) allocating water resources through solar power system;
(4) increasing the slope stability by implementing dry masonry embankment construction, a low-impact and with traditional wisdom practice;
(5) improving community resilience after establishing water reuse system and restore SEPLS;
(6) developing products/services for a sustainable economy.

Under cross-sector collaborative structure (government-university-community), an array of actions have been implemented to achieve sustainability of SEPL, such as forest and wildlife habitats restoration at upstream catchment area, practicing eco-friendly farming to maintain healthy agricultural ecosystems, promoting smart allocation and mitigation overused of water resources, preserving and re-introducing traditional wisdom (e.g., dry stone masonry), developing community industry to boost local incomes.

2.1. To practice eco-friendly farming practices and enhance ecosystem health on SEPLS

From 1970 to 2000, a large amount of chemical fertilizers was applied to boost yields in agricultural production, which brought cumulative damage to environments and ecosystems. Particularly, pesticides and fertilizers could wash into river and irrigation system through rain, threatening fish and other aqua-organisms greatly. Excessive use of hazardous chemicals could also contaminate soil and ground water, bringing health risks on local farmers and consumers.

Since a group of community residents started to realize harmful causes of chemicals on health, environments, they decided to seek out for professional assistance. A series of training courses had hold by experts from Council of Agriculture, Taiwan (a government agency) on orchard management, such as precision farming, rational fertilizing and safety standard of pesticide application. The community association also worked together with various academia, government agencies, or NGOs and continues educating locals regarding long-term impacts of chemical fertilizers and pesticides on soil productivity, farmland ecosystems, harvest quality and human health. Moreover, local residents began to call for meetings if any related issue need to be resolved

or any assistance is required. This communication mechanism can be seen as the prototype of the future Communications, Education, and Public Awareness (CEPA) strategy.

In 2012, the Gonglaoping Community joined the rural regeneration plan that is funded by the Soil and Water Conservation Bureau SWCB). Under the project operating framework, they held 9 "Training of Trainers" (TOT) workshops, training locals on organic fertilizers and pesticides as well as their development and use. Lecturing contents include applications of a biological fertilization, Trichoderma, to treat the plant disease and practices of lychee stink bug biocontrol by introducing *Anastatus japonicus* (wasps). Currently, eco-friendly farming coverage (e.g., persimmon, citrus, longan) has been expanded up to 15 ha, 12.5% of the total production area.

In 2017, the community set up a water quality monitoring system in order to prevent agricultural sewage pollution and started on making long-term observation records, particularly examining the streamflow and water quality of upper, middle and lower streams in study areas. Indicators include conductivity, pH value, actual dissolved oxygen (DO), nitrate concentration, total phosphorus and biochemical oxygen demand (BOD). Furthermore, various fish and amphibians have been spotted afterward, such as Taiwan striped barb *(Acrossocheilus paradoxus*), Formosan stripe dace (*Candidia barbata*), Goby (*Rhinogobius rubromaculatus*), Carp (*Carassius auratus*), Temple tree frog (*Kurixalus idiootocus*), Brauer's tree frog (*Polypedates brauerii*), Latouchte's frog (*Hylarana latouchii*), Gunther's frog (*Hylarana guentheri*), Ornate narrow-mouthed toad (*Microhyla fissipes*), Fujian large-headed frog (*Limnonectes fujianensis*), Rice field frog *(Fejervarya kawamurai*).

Figure 3. Eco-friendly framing practice trainings (Source: GIDA)

2.2. To mitigate overused water resources by smart allocation strategies built upon local mutual trust

Precipitation in Gonglaoping concentrates from April to September while the dry season occurs in November to January. Although the spring water upwells from the headspring of Han River, the amount of water is insufficient to fulfil local demands; so that causes farmers to extract groundwater for irrigation. Along with climate change impacts in Taiwan is getting more and more serious, the dry season is becoming longer, leading to overpump groundwater at upstream, which could jeopardize water rights of human and other species living in middle stream and downstream areas. According to that, the community requested assistance from the SWCB and made plan to dredge severely silted ponds and build up reservoirs. The total volume of reservoirs was expanded

from the original 56 tons to 416 tons approx... It can be used to store rainfall in the wet season on purposes to supply irrigation water in summer and winter. As shown in Figure 4, the smart water resources management and recycling system can allocate water resource precisely and effectively. For example, when the water level of the 1st and 2nd ponds drops, the system would flag a signal to pumping motor and the water in the downstream No.3 pond will be pumped up and distributed to the 1st and 2nd ponds. Additionally, the pumping system is powered by solar energy.

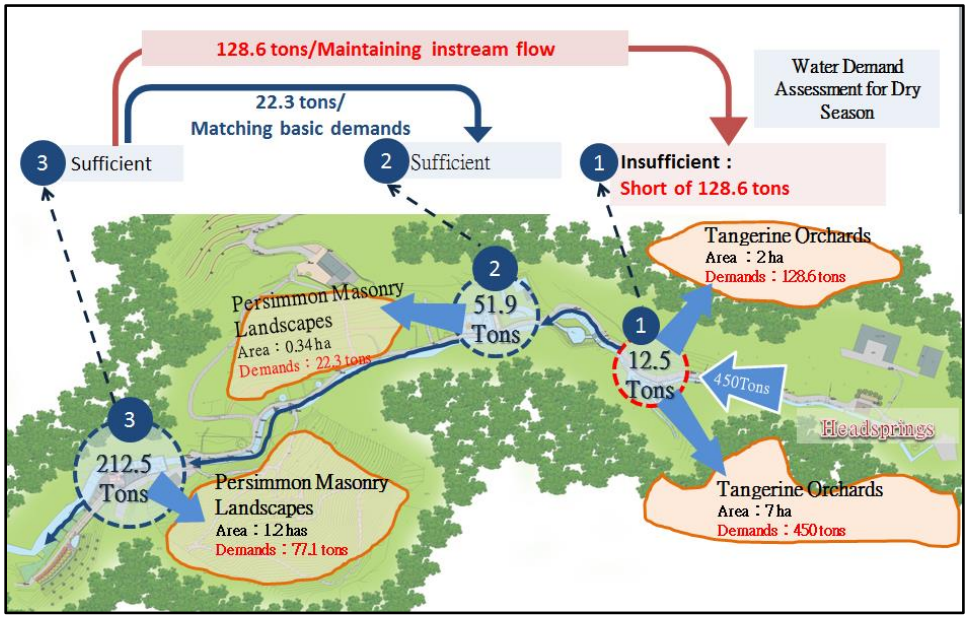

Figure 4. The water resources management and recycling system for Han River's upstream

In order to mitigate low soil water retention, vegetated buffer strip cultivation is adopted to improve soil physical and chemical characteristics, such as increasing organic matter contents, soil drainage and aeration. It can prevent the root damaging due to sudden changes in soil temperature as well. Grass roots can also retain soil moisture and nutrients, thus preventing rapid leaching of nutrients. The decomposition of grass roots can supply a large amount of carbon and nitrogen sources to beneficial microorganisms, which can enhance soil microbial cycles. In Gonglaoping, 91% of farm lands are currently practiced vegetated buffer strip cultivation. The other 9% is slope land that can be difficult to artificially weed. However, the orchard owner knows the advantages of vegetated buffer strip cultivation and tried his best not to use herbicides. Farmers have recognized that vegetated buffer strip cultivation can not only improve the soil properties, but also contribute to environment and ecosystem protection.

Figure 5. Formation ceremony of the Han-River Neighbourhood Watch (Source: GIDA)

Moreover, the community forms the Han-River Neighbourhood Watch to patrol environments regularly and voluntarily. The mission statement is to guard the headspring water, to monitor the streamflow, and to coordinate water resources allocation. The major duties include but not limited to: (1) to pay attention on ecosystem health; (2) to maintain a clean community; (3) to account for the regular cleaning and maintenance of reservoirs. The neighbour watch is also responsible for the maintenance of weather stations, water level gauges and monitoring data. All members should attend regular working meeting, report maintenance results, and exchange experiences every Tuesday night.

2.3. To preserve and re-introduce traditional wisdom, dry stone masonry landscapes

On September 21 of 1999, a magnitude 7.3 earthquake occurred, which was the largest natural disaster in Taiwan in the 20th century. Gonglaoping community was also traumatized. Residential houses were damaged; masonry embankments were collapsed; roads and hiking routes were broken. After the earthquake, the community initiated a series of post-disaster recovery and reconstructing projects. In order to strengthen resident cohesion and set development goals properly, the Gonglaoping Industrial Development Association of Fengyuan District, Taichung takes the lead and implements the Rural Regeneration Project funded by SWCB since 2010.

In August of 2010, the community began a 4-stage, 92-hour rural community development training courses, in particular, learning how to document community life, production, ecology, culture and other resources; then set development vision and goals independently. Through the capacity building, it empowers community and ensures that benefits of participatory, community-led approach are clearly understood. In 2012, they completed and got approval of the rural regeneration plan proposal. After implementation of the rural regeneration plan, the Gonglaoping Community actively and independently applied governmental funds to improve the community environments, to conduct cultural and ecological surveys, to implement community guides training programs, and to organize citrus industry activation activities every year.

Masonry production landscapes are situated at the upstream of the Han River. The surrounding trail was damaged by the earthquake and could be inconvenient and dangerous to the elders. The development association has actively sought the government funds to restore landscapes of masonry walls at the headspring of Han River. Regarding the particular matter, locals have reached an agreement to use participatory design method to renovate embankments on both sides and to restore unique masonry SEPL together. Until now, the community has gradually repaired the destroyed masonry landscape about 2,300 meters, and restored to 4-ha production areas, estimating restoring

about 120 tons of persimmon production. In 2017, Gonglaoping held several dry masonry construction workshops and invited masonry craftsmen, Mr. Liu and former director Mr. Tsai to teach the local youth. The participating residents said that the theological concept of masonry method may not difficult to understand. However, it really needs efforts and skills for implementation. Through sharing experiences and key skills by the master craftsmen, it not only promotes a useful construction method but also ensure the inheritance for the essence of traditional masonry method. On top of that, the Gonglaoping community can implement a low-impact practice for slope stability, achieve resources recycling cycle, maintain environmental capacity and pass traditional heritage to next generations, which are all proposed objectives of the Sotoyama Initiative.

Figure 6. Dry masonry construction workshops (Source: NCHU and GIDA)

2.4. To cease further habitat degradation through natural succession and create more organism refuges

In the 1960s, locals began to realize the importance of water and soil conservation and promote farmland fallow at the upstream catchment area of Han River. Thus, they gradually moved toward downstream for agricultural activities. Comparing with orchards situated at terraces, those lands in the upstream area requires much more affairs to grow and manage crops. Besides, farming operators are getting older and their capable farming areas are slowly shrinking as well. In this case, abandoned lands are increasing, grows with less disturbance of human activities and turn into a secondary forest by natural forest succession. This process creates wildlife habitats and makes this region with abundant biodiversity. After 50-year natural succession, it has become a 109-ha natural forest. Field survey has documented 54 species of plants and 30 species of avian. It is evident that here are important wildlife habitats.

Additionally, stone masonry embankments on hillside are constructed by a triangular stacking method, called traditional herringbone method. The stone wall with irregular cobbles has cavities in different sizes, providing space as organism refuges for small animals to hide and plants to grow. The common species include Taiwan Maesa (*Maesa formosana Mez.*), Taiwan scouring rush (*Equisetum ramosissimum Desf.*), Skunk-vine (*Paederia cavalerieri auct.* non H. Lev.), Sword brake (*Pteris ensiformis* Burmann), Tuberous sword fern (*Nephrolepis brownii (Desv.)* Hovenkamp & Miyam), Acuminate leaf morning glory (*Ipomoea indica* (Burm. f.) *Merr.*), Five-striped blue-tailed skink *(Plestiodon elegans*), Swinhoe's japalure (Diploderma swinhonis), gossamer-winged butterflies, ants, etc. According to acknowledge importance of masonry walls as wildlife habitats,

community elders have led local youth to restore 3,100-m long embankments, creating around 5,400-square-meter spaces for wildlife.

2.5. To develop community industry and ensure local incomes

Urbans often has more job opportunities and offer better salaries. Since the Gonglaoping community is near the downtown of Taichung city, young people tend to migrant to the cities, causing problems of aging labor force and industrial recession. Residents in Gonglaoping who are elder than 60 years old at least accounts for the 20% of total population.

After the establishment, the Gonglaoping Industrial Development Association has actively applied for funding to hold industrial revitalization activities and community festivals in order to attract investors and tourists. For example, the Citrus Industry and Culture Festival in 2016 had at least 3,000 visitors. It brought a 30 percent increase for local incomes through agricultural product sale with revenue about 300,000 NTD (~10,000 USD). The hotel accommodation rate also went 20% higher than usual. The increase and recognition of tourists enhances local youth's confidence on business opportunities and career possibilities in their hometown.

Young generation farmers who move back to hometown have insisted on practicing organic and eco-friendly farming to grow citrus and persimmon for the purpose of protecting natural resources and environments. Although mature fruit (e.g., citrus) did not have attractive appearance and couldn't sell in a good price During the transition period, local famers unleashed their creativity to make a wise turn. Instead of making money by traditional table fruit, they developed two post-harvest, processed products, organic persimmon leaf tea and organic citrus gummy that generate more profits. Both products are made from local persimmon and citrus orchards that are cultivated by organic farming. The tender persimmon leaves that have just grown in spring are carefully selected for processing. Persimmon leaves are highly nutritious and rich in protein, amino acids and multivitamins. The tea is also acknowledged as Rural Goodies (i.e., good products from rural communities) by the SWCB, generating revenue up to 370K NTD (~12,300 USD) per year. In addition, the organic citrus gammy is a soft candy made from local mandarins. It is named as one of the best ten souvenirs in Taichung City by media and now can be bought on the Taichung City Government E-commerce and Sales platform with an annual revenue of 660 K(~21,900 USD) NTD.

Figure 7. Organic agriculture products of the Gonglaoping Community (Source: GIDA)

Under the leadership of the young chairman Mr. Lu, the Gonglaoping community presents more lively activities. They tried to operate four in-depth agricultural tours based on four seasons (i.e., spring, summer, fall, and winter); so that people from all over the world can better understand the local characteristics of Gonglaoping. Local industrial development and promotion events include "Spring Tour in Gonglaoping - Orange Blossom Watching and Citrus Essential Oil DIY", "Lovely Lychee in Gonglaoping - Fengyuan Lychee Festival and Outing", "Autumn Praise: Gonglaoping Persimmon Banquet and Rural Chinese Orchestra Concert", "Winter-When Tangerine Turn Red--Gonglaoping Picnic Party." The total number of visitors is up to 1,450 with an estimated 25% return rate and the total economic benefit is 1.27 million NTD (~4.21 million USD). It implies that the innovations of community activities in Gonglaoping are able to constantly attract various custom groups to attend.

3. Results

With the hard work of the Gonglaoping Community and cross-sector collaboration with multiple stakeholders, including SWCB, NCHU and other local groups, evident achievements are reported as follows.

(1) Resolving conflicts of water use by increasing water storage capacity and reducing groundwater consumption during the dry season

The rainfall patterns in Gonglaoping are uneven by seasons. The rainy season is in summer while the dry season is in winter. Both persimmon growing period (summer) and dry season require a lot of water for irrigation. However, the Han River cannot provide adequate amount of water at the same time; thus farmers often turns to solve issues by pumping groundwater , which affects water and groundwater usages of residents living at the middle and down streams. According to that, community carried out expansion of the original water detention capacity and also built terraced-type, ecological engineering reservoirs by consulting experts in SWCB and NCHU. The total volume of reservoirs was expanded from the original 56 tons to 416 tons. Based on estimation, if the reservoir is up to full capacity during the rainy season, it would able to match water demands during the dry months (e.g., February and March), estimated reducing the amount of groundwater used for 5 weeks. The groundwater extraction volume reduced from the original 510 to 93 tons. On the other hand, irrigated areas that are supplied by Han River increased from 10 Ha to 14 Ha (17.5% of the catchment area) and also bumped up the persimmon production about 120 tons. This construction is a win-win strategy in alleviating insufficient irrigation problem and conserving wildlife habitats.

(2) Restoring traditional masonry SEPL

Hillside orchards represent a unique SEPL with multi-layer stone masonry embankments. It can conserve water, stabilize slope and provide spaces as organism refuges. Holes and cavities between become homes for various small-sized creatures. Locals have repaired 2300 meters of masonry embankments and have increased 4-ha plannable areas accumulate. Vegetated buffer strip cultivation is implemented on farming as well that benefits environments in many ways, including to reduce the herbicide use, alleviate soil erosion, balance soil moisture, increase soil nutrients, maintain healthy soil ecosystems, and so on.

(3) Empowering, enhancing and sustaining local operation through leadership of a community-led NGO, the Gonglaoping Industrial Development Association

The Gonglaoping Industry Development Association plays a vital role in sustainable water resources management. It was established in 2004 and has experienced seven directors. All previous directors continue to participate in community industrial development. The association meets regularly every Tuesday night to discuss subjects regarding all development affairs and also gel all residents as a whole to promote industrial revitalization. For the protection and rational use of Han River's water resources, it plays the role for management and coordinating. In order to mitigate conflicts in the process of irrigation, residents reached an agreement to set up a neighborhood watch to patrol the Han River and drafted a convention to conserve water resources of Han River and manage the community.

Figure 8. Community development meetings that have been held in 15 consecutive years, every Tuesday night (Source: GIDA)

(4) Enhancing benefits of green industries: the new economic and ecological values of organic industries

The returning youth flip the old mind that orchards can only produce table fruits for sale. They developed organic products such as persimmon leaf tea and citrus gummy to add new economic values on local industries, particularly, adapted innovative post-harvest process technology to make new healthy foods. The persimmon leaf tea can earn twice profits than traditional agricultural product sales while and the revenue of citrus gummy is even better with 10 times boosts. Because both products emphasize on organic concepts and zero fertilizer residues, the success of these products provides solid evidences on benefits, brings new insights on farming practices and then motivates transformation. Community residents become much willing to accept eco-friendly farming practices, which is a true win-win strategy to maintain water quality, biodiversity and sustainable economic revenue.

4. Discussion

The foothill development often requires slope stabilization. The dry masonry piled up with in situ materials not only solves the problem of stone placement after site preparation but also has good water permeability and generate habitat for fauna and flora. The masonry SEPL present many valuable functions, including soil and water conservation, a low –impact practice, maintaining biodiversity, creating organism refuges, integrated applications of traditional knowledge and even sightseeing.

Constrained by micro-climate conditions, the Gonglaoping is often short for the irrigation supply in dry seasons. Fortunately, most community residents are aware of and understand

particular issues; then, show empathy to each other. Based upon mutual trust, locals are able to establish a strategic, decision-making routine on weekly basis. It divides water allocation by divisions and time slots, so that all orchards can maintain growth. Also, the water allocation plan is reviewed and determined whether revision is needed also by week. It successfully avoids conflicts caused by competing water sources and mitigates over pumping of ground water in dry seasons. Hence, this communication mechanism can be considered an effective strategy and incentives to encourage CEPA activates.

Gonglaoping community is situated at the upstream of Han River. Over-dose fertilizers and pesticides could impact water quality and risk residents' health. Also, the irrigation relies on river water supply, leading to a vicious circle. The farmers understand that high quality fruit can only produce from a health ecosystems and good water quality. Thus, in addition to rejecting herbicides, they are also willing to try different eco-friendly farming practices, on purposes of maintaining the ecological environment and water quality near the Han River. Several local farmers have cooperated with government agencies to apply Trichoderma instead of pesticides and chemical fertilizers, and also perform Lychee Stink Bug biocontrol by introducing *Anastatus japonicus* (wasps).

In the process of post-disaster recovery and restoration, the community has created numerous job opportunities with leisure agriculture and has hosted a variety of activities/events to lure visitors from urbans. These opportunities now become the motivation to attract young people moving back home. Besides, proposed ideas of these returning youths are accepted by the community more, and they participate more for local affairs, then roots even deeper with community. In 2016, the chairman of the board of community association was re-elected. The community believes that passing down authority to the young generation can open a new era and broaden the path to future prosperity. Thus, they voted a returning youth to serve as the new chairman. The new chairman and other returning youths are led by the former president, which helps them get familiar with community affairs quickly. Also they flip the traditional way of organizing events by integrating online marketing, social media and other trendy concepts. It makes the activities more dynamic and shines the Gonglaoping community's features.

The Gonglaoping Industrial Development Association (GIDA) shows tight connection with locals, actively proposes improvement plans, and acts as a "glue" agent, cooperating closely with various governmental agencies, private sectors, and other NGOs. This multi-stakeholder platform can empower locals and enhance implementation of the Sotoyama Initiative. These stakeholders include Taichung Branch of SWCB, Agricultural Bureau of Taichung City Government, NCHU, Fengyuan District Farmers' Association, Agricultural Research and Extension Station, Taiwan Agricultural Chemicals and Toxic Substances Research Institute, etc.

5. Conclusions: Key Messages

To achieve sustainability of SEPLs not only requires applications of a holistic approach but also take affairs for cross-sector collaboration (community-government-university). Key messages of this case are:

(1) The masonry SEPLS present many valuable functions, including soil and water conservation, a low –impact practice on slope stabilization, maintaining biodiversity, preserving traditional wisdom and even sightseeing.
(2) Constrained by micro-climate conditions, the Gonglaoping is often short for the irrigation supply in dry seasons. Locals have learned to facilitate a strategic, decision-making

routine, which the water allocation plan will be reviewed and revised by week, so that all orchards could maintain growth. Besides of that, this mechanism can avoid conflicts of water use and halt overuse of ground water in dry seasons. The key element of such effective operation is mutual trust among community residents.

(3) Because success of organic products, locals are more willing to practice eco-friendly farming, which is a true win-win strategy to sustain water quality, biodiversity and economics.

Hence, we are confident that the Gonglaoping Community case could be an example for practical implementation of the Sotoyama Initiatives on hillside, agricultural landscapes in East Asia.

6. Acknowledgements

Sincere gratitude and thanks are expressed to local residents, farmers, and different groups of Gonglaoping community, providing valuable assistance for the study. We have prepared associated contents as an IPSI case study and are planning to submit to the IPSI Secretariat as a case study. The work was supported by Rural Reaeration fund of the Soil and Water Conservation Bureau, Council of Agriculture, Executive Yuan, R.O.C. (Taiwan).

7. References

- Bélair C, Ichikawa K, Wong BYL, & Mulongoy KJ (eds) 2010, *CBD Technical Series: Sustainable use of biological diversity in socio-ecological production landscapes: Background to the 'Satoyama Initiative for the benefit of biodiversity and human well-being.'*, Secretariat of the Convention on Biological Diversity, Montreal. Technical Series no. 52184 pp.
- Hodgson, S 2006, *FAO Legislative Study 92, Modern water rights: Theory and practice*, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
- Natori, Y, Dublin, D, Takahashi, Y, & Lopez-Casero, F 2018, *SEPLS: Socio-ecological production landscapes and seascapes -experiences overcoming barriers from around the world*, Conservation International Japan, Tokyo, Japan.
- PREC Institute Inc., and United Nations University Institute of Advanced Studies (UNU-IAS) (eds) 2010, *Biodiversity and Livelihoods: the Satoyama Initiative Concept in Practice*. UNS-IAS, Ministry of Environment of Japan, Yokohama, Japan.
- SWCB Taichung Branch, COA., R.O.C. (Taiwan) 2017, *2017 Rural Community Intelligent Disaster Prevention and Satoyama Initiative Practice in Hillside Area*, SWCB Taichung Branch, COA., R.O.C. (Taiwan), Taichung City, Taiwan.
- SWCB Taichung Branch, COA., R.O.C. (Taiwan) 2018, *2018 Strategy Development and Implementation of the Sotoyama Initiative in Chung-Miao Rural Communities*, SWCB Taichung Branch, COA., R.O.C. (Taiwan), Taichung City, Taiwan.
- UNU-IAS, Biodiversity International, IGES and UNDP 2014, *Toolkit for the Indicators of Resilience in Socio-ecological Production Landscapes and Seascapes (SEPLS)*. Secretariat of the IPSI, UNU-IAS, Tokyo, Japan.
- UNU-IAS and IGES (eds.) 2018, *Satoyama Initiative Thematic Review vol. 4: Sustainable use of biodiversity in socio-ecological production landscapes and seascapes and its contribution to effective area-based conservation*, UNU-IAS, Tokyo, Japan.