Transformative Learning as a Ground-up Approach to Sustainable Development: Narratives from Vietnam's Mekong Delta

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Abstract

As the Vietnamese government continues to seek appropriate actions to move the national action on climate change forward, the emergence of grassroots sustainability initiatives has the potential to promote sustainability from the ground up. This paper reviews the current concepts of transformative learning (T-learning) and its importance through which some substantial linkages between T-learning and sustainability can be identified. It outlines the environmental changes in Vietnam's Mekong Delta, which appear to serve as "disorienting dilemmas" that force the local people to learn and gradually transform their behaviors and lifestyle choices to align with a low-carbon and sustainable development. In an ideal T-learning approach, the major beneficiaries are the small-scale farmers, women, and ethnic groups (learners). They learn by doing under the supervision of educators (experts) in field-based schools that offer real-life experience and encourage learners to shift from traditional farming practices to modern, eco-friendly agricultural models that promote local economic self-reliance and biodiversity conservation. The paper sheds new light on how a critical approach to education for sustainable development through T-learning is an appropriate form and why T-learning should be acknowledged as an important part of the broader approach to self-help, climate resilient development in vulnerable communities.

Keywords: transformative learning, education for sustainable development, community climate action, climate-resilient development, VACB in Mekong Delta, mangrove-shrimp farming system

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Introduction

Vietnam has an economy that heavily depends on agricultural exports for national growth. Thus, the Mekong Delta has long been referred to as Vietnam's "rice bowl", where almost 80 percent of the population is engaged in agriculture and fishery. For generations, small-scale rice farmers have completely relied on the Mekong's nutrient-rich water and the abundance of fish for their subsistence, with very little margin for error.

However, the local residents' way of life is facing an existential threat, and the next decade will be critical to the future of the delta. The local inhabitants and experts see Mekong and its tributaries in Vietnam as a resource to be nourished and sustained for future generations. However, rivers and their catchments—the lifeblood of the region—are increasingly threatened by the changing weather and the continued construction of Mekong upstream dams. The Washington Times (2016) reported that the ill-conceived development schemes undertaken by the delta's state authorities add another danger to this environmental security risk, thereby undermining local livelihoods and ecosystems that completely rely on the delta's rivers.

The failure of recent international negotiations to progress global action against climate change has shifted the world's attention to the emergence of grassroots sustainability initiatives (Mezirow and Taylor 2009; Chiem 2012; Kent 2016). Civil society networks have demonstrated an effective strategy to engage in community-based low-carbon practices and sustainability transition in order to address the challenges that government authorities sometimes struggle to solve. Thus, there is potential to implement social innovation and change from the ground up.

In recent years, geographers from Can Tho University, in collaboration with NGO partners, have mobilized local people to engage in different transformative learning models that aim to raise public awareness and promote and facilitate harmonious solutions deemed necessary for the progress and climate-smart evolution of the people and ecosystems (Chiem 2012; Quang and Weatherby 2019).

Conceptually, the process of transformative learning, or T-learning, emerged in response to the "disorienting dilemma"—an experience or self-perception that no longer fits into a new situation (Mezirow and Taylor 2009). "Disorienting dilemma" forces people to reconsider their beliefs and lifestyles through critical reflection and a dialogue with their community. In disaster-prone regions such as the Mekong Delta, the ongoing environmental injustices serve as a key "disorienting dilemma" to individuals (e.g., farmers, women, and ethnic groups) who must transform their behaviors and lifestyle choices in order to align with a sustainable low-carbon future.

T-learning models have many positive impacts on community capacity building and environmental protection (Chiem 2012). However, the number of empirical examples that demonstrate the factors that enabled community-based social innovations to achieve more widespread adoption outside of their local sustainability niche remains limited (Kent 2016). This highlights the need to continue theorizing grassroots climate action in terms of their sustainability transition potential, in which T-learning is an integral part in intra- and inter-community education. In this respect, several questions need to be addressed as follows:

1. What is grassroots T-learning and how does it promote community climate action in disaster-prone areas such as the Mekong Delta?
2. T-learning has the potential to influence grassroots activism on climate change; thus, it holds the key to sustainability transition and broader climate change governance. Accordingly, in what ways can T-learning promote the community based collectives toward climate-resilient development in accordance with sustainability needs? Does T-learning lead to sustainability? If yes, how can it best be implemented as an alternative approach to sustainable development at the local level?

This paper aims to clarify the importance of T-learning in grassroots climate action. It also

aims to demonstrate why this strategy should be acknowledged as a ground-up approach to sustainable education.

Understanding T-Learning: Concepts and Approach

T-learning as a concept originated from Jack Mezirow (1990, 1991). It is known as a theory that describes a process of examining, questioning, and revising people's perceptions of their experiences that they interpret in their own way. One of the goals of education is to find universal truths and constructs that are independent of our knowledge of them. Thus, humans develop habitual expectations and assumptions based on past experiences and expect things to be as they were before. However, when individuals encounter a situation that is not congruent with their expectations, they begin to reconsider the existing perspectives that guide their decision making and actions and enter into a process that could lead to a transformed perspective (Taylor and Cranton 2012). Some scholars define T-learning as a learning process that "transforms problematic frames of reference to make them more inclusive, discriminating, reflective, open, and emotionally able to change" (Mezirow and Taylor 2009, 22). However, the major element of T-learning is individualization of responsibility for mainstream change. In some contexts, social change may need to precede individual change; in others, individual change drives social transformation. Thus, the individual shift in perspective is the key to broader community and social change.

Mezirow (2009) argues that people would likely consider changing their view of the world when they face a "disorienting dilemma"—an experience that no longer fits into emerging circumstances or beliefs. When faced with a disorienting dilemma, people are forced to reconsider their understanding of the world and look for a new, appropriate way to fit the new experience into the rest of their worldview. This process of "self-adjustment" often happens through "critical reflection" through engaging in dialogues with other actors, including academics, and those who pursue interests conflicting with theirs (Howie and Bagnall 2013). Such a transformative process is comprised of ten phases as follows (Mezirow 2009, 19):

1. A "disorienting dilemma"
2. Self-examination
3. A critical assessment of assumptions
4. Recognition of a connection between one's discontent and the process of transformation
5. Exploration of options for new roles, relationships, and action
6. Planning a course of action
7. Acquiring knowledge and skills for implementing one's plan
8. Provisional trying of new roles
9. Building competence and self-confidence in new roles and relationships
10. A reintegration into one's life on the basis of conditions dictated by one's new perspective

T-learning is an emerging approach that is becoming increasingly preferred in schools and community education. In public schools, teachers use "disorienting dilemmas" to challenge students' thinking and to encourage them to use critical thinking. In such a way, the students are encouraged to verify their underlying assumptions and beliefs, and accordingly look for new experience or perspective (Christie et al. 2015). In academic learning environments, "disorienting dilemmas" often occur when teachers provide students with the space to critically pursue new ideas. To utilize T-learning in classrooms, teachers primarily need to provide the students with enough space and opportunities that would cultivate their critical thinking. Teachers can do this by enabling students to engage in new content through journaling, engaging in dialogues with their peers, and critically questioning their own assumptions and beliefs. Once the students have challenged their own assumptions and beliefs, it is important for the teachers to provide the students with the opportunity to act on the new beliefs they have found. This step is necessary since true transformation cannot take place unless the students are able to actively take steps that

acknowledge their new belief (which is either right or wrong) (Christie et al. 2015; Howie and Bagnall 2013).

However, teachers must consider sustaining students' transformed perspective by providing opportunities to relate with others who are going through the same transformative process. Transformation often happens in a community as students bounce their ideas off with one another and are inspired by the changes that their friends and acquaintances make. In other words, the disorienting dilemmas in academic environments and those in communities look more or less alike. Students are more likely to act like how their parents and neighbors usually do, which are sometimes different, or even contradictory with what they acknowledge in school.

Despite this understanding and relationship between fostering T-learning in school and in communities, the role of T-learning in a community generally remains underresearched in Vietnam. We recognize that local farm communities can be acknowledged as a natural point for sustainability education. Their position in policy processes, which is often marginalized, motivates them to support equitable development approaches as both the first beneficiaries and as future victims of mismanagement.

On the other hand, The Diplomat (2017) reported that the Mekong Delta will soon be the country's next environmental hotspot, as factories and other potential polluters proliferate along the waterways. Hence, the logic behind is that if local communities want sustainable development, then they need T-learning in order to improve their own resilience capacity and accordingly find out clear alternatives to the harmful anthropogenic activities. Pursuing climate-smart livelihoods would help them to gain better income while avoiding far-reaching environmental impacts that their children will be forced to bear in the future. Local communities, therefore, have an opportunity to help determine an alternative policy in order to self-help climate-resilient development in the delta. However, this is only true if the communities are fully engaged in the T-learning process, which offers an ideal platform for enhancing their capacity and real-life experience (Mezirow and Taylor 2009; Christie et al. 2015).

The following section presents the development of grassroots T-learning in the Mekong Delta, in which the major elements that frame the T-learning approach and the impacts of T-learning on local sustainability transition are identified and analyzed.

Dawn of T-Learning in the Mekong Delta: Case Studies from Can Tho City and Ca Mau Province

This section presents two case studies of T-learning in two areas where the physical and socioeconomic conditions are different from each other (Figure 2). The first case study is in Phong Dien district in the outskirts of Can Tho City, the premier city in the Mekong Delta. Phong Dien district is noted for its floating market, paddy fields, and picturesque rural canals. The other narrative is from Phong Dien, a coastal, disaster-prone commune in Ca Mau province that borders the Gulf of Thailand. Majority of the commune's population is poor, unskilled, and quite vulnerable to sea level rise and extreme weather conditions. Since 2000, local farmers in Phong Dien commune have been mobilized to encourage them to shift from rice farming to shrimp farming, followed by industrialization. This has caused ecological imbalances due to the huge-scale deforestation and environmental pollution brought about by industrialization (Quang and Weatherby 2019).

The following subsections aim to provide field-based analysis and some research findings to contribute to the theory of the role of T-learning in grassroots sustainable transition and climate resilient development in the Mekong Delta.

T-Learning in Freshwater-Based Agriculture

Since the early 2000s, T-learning activities have been introduced in several rural villages around the Mekong Delta. Some agricultural and environmental scientists from Can Tho University have introduced new technologies to the local

farmers in Can Tho City and supported them to gradually change their livelihoods. In particular, farmers have shifted from traditional farming models to modern, eco-friendly agricultural ones. Initially, six local smallholders in Phong Dien district were chosen to engage in the T-learning program under the supervision of experts and volunteers. They are small-scale farmers whose land areas vary from less than 1 ha to 2 ha. They are characterized by family-focused motives, such as using mainly family labor for production and using part of the produce for family consumption. They have practiced monoculture, particularly rice farming (one crop per year), producing low and vulnerable yield until 1990. From 1991 to 1996, they transitioned from rice farming to establishing orchards, in which orange and mango were the main crops. Horticultural crops helped to increase their incomes. A few years later, however, extreme weather conditions and price drops quickly led the farmers to the brink of bankruptcy.

The selected farmers are those who have years-long experience in farming and are recognized in their villages. They were committed to sharing their experiences and progress reports with their neighbors. In particular, the farmers were supported to set up a few sample fields, where low-carbon and climate-resilient agricultural model, called the VACB model, was employed. The VACB is a polyculture model that combines four elements: *vuon* (literally means orchard), *ao* (fish farming/fishpond), *chuong* (livestock farm), and biogas. The model aims to increase and stabilize farmer revenues and reduce environmental damages caused by traditional intensive monoculture. This farming system is also family-managed, with practically all labor coming from the household.

In the VACB model, orchards (V) usually vary from a few hundred to 5,000 m^2 and are comprised of fruit- or nut-producing trees that are generally grown for commercial production. Commonly grown fruit crops include orange, pomelo, *mengteng* (a sour, lychee-like fruit), durian, rambutan, and mangosteen. The vegetables grown include green onion, sweetpotato, cress, tomato, cabbage, and water spinach. Both perennial and annual crops are planted to provide year-round food to the house and products for the market.

Meanwhile, fishponds (A) are usually constructed close to the house and surrounded by orchards. There can be a few small fishponds in a 1-ha orchard, with different shapes and an average depth of 1.2–2.0 m.

The livestock pens (C) for pigs are constructed at the corner of the orchard close to the pond. Pig dung no longer gets washed into the river nor becomes concentrated around the farm because it is drained by an installed bio-digester that transforms livestock manure through anaerobic digestion into fertilizer for algae (a commonly used food source for fish) and methane gas, an environmentally benign biogas (Bosold 2012).

Lastly, the biogas system (B) digests pig dung and vegetation and generates the methane gas by-product, which is used for cooking, power generation, and pumping water to irrigate the orchards. Digested and clean organic materials are then released to the surrounding fishponds, where it acts as fertilizer (Bosold 2012). Figure 1 illustrates how the VACB elements are intertwined and support each other in the system.

After two years of implementation, the VACB sample fields have resulted in fruitful outcomes, generating higher income for the local residents, while minimizing the pollutant emissions. Many of the research findings have confirmed that the VACB model is especially beneficial to women, as it reduces the time they spend to collect fuel, cook, and clean cookware grimed by wood smoke. It also saves them money as it eliminates the cost of commercial gas or firewood. Likewise, it improves their health by managing animal waste and by reducing indoor air pollution from woodstoves (Bosold 2012; Chiem 2012; Clare 2017).

Since 2000, the number of participating family representatives in the program has rapidly increased annually. From 110 participants in 2000, it increased to 625 in 2012 (Chiem 2012), mainly due to the technical and financial assistance from Can Tho University and NGOs. However, the expansion of the VACB model to other communes slowed down when pig prices decreased nationwide

Figure 1. Typical VACB system in the Mekong Delta

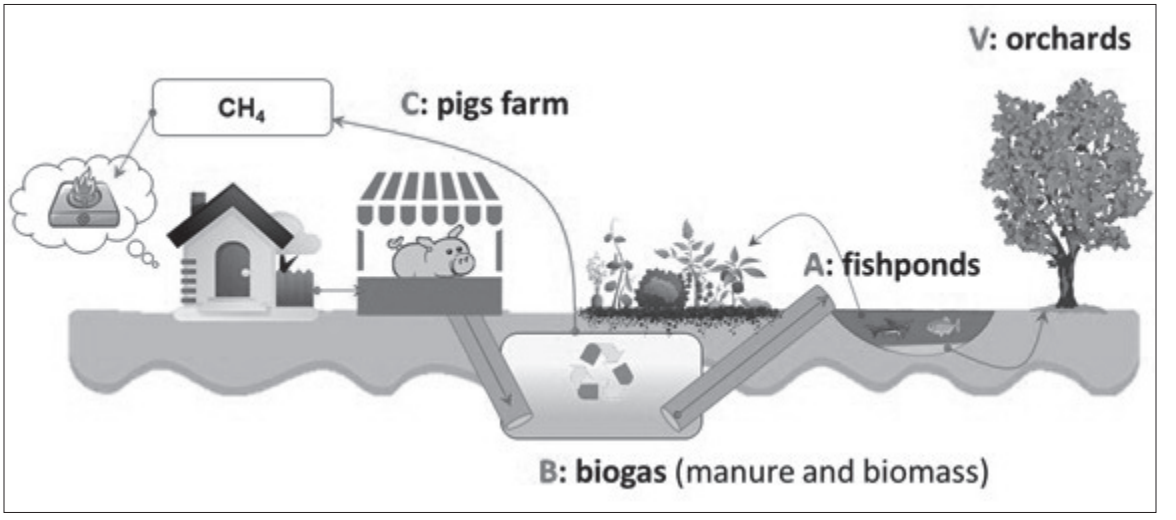


Table 1. Number of VACB participants by gender, age, and ethnic group

Year	Participants	Gender		Age			Ethnicity	
		#	Percentage	18 - 45	46 - 60	> 60	Vietnamese	Khmer
1996	6	6	0	2	3	1	6	0
2000	110	93	17	31	37	41	102	8
2008	300	269	31	87	101	112	277	19
2012	625	497	128	137	176	312	594	31
2017	642	513	129	135	184	323	597	45

Source: Chiem (2012) and authors' 2017 surveys

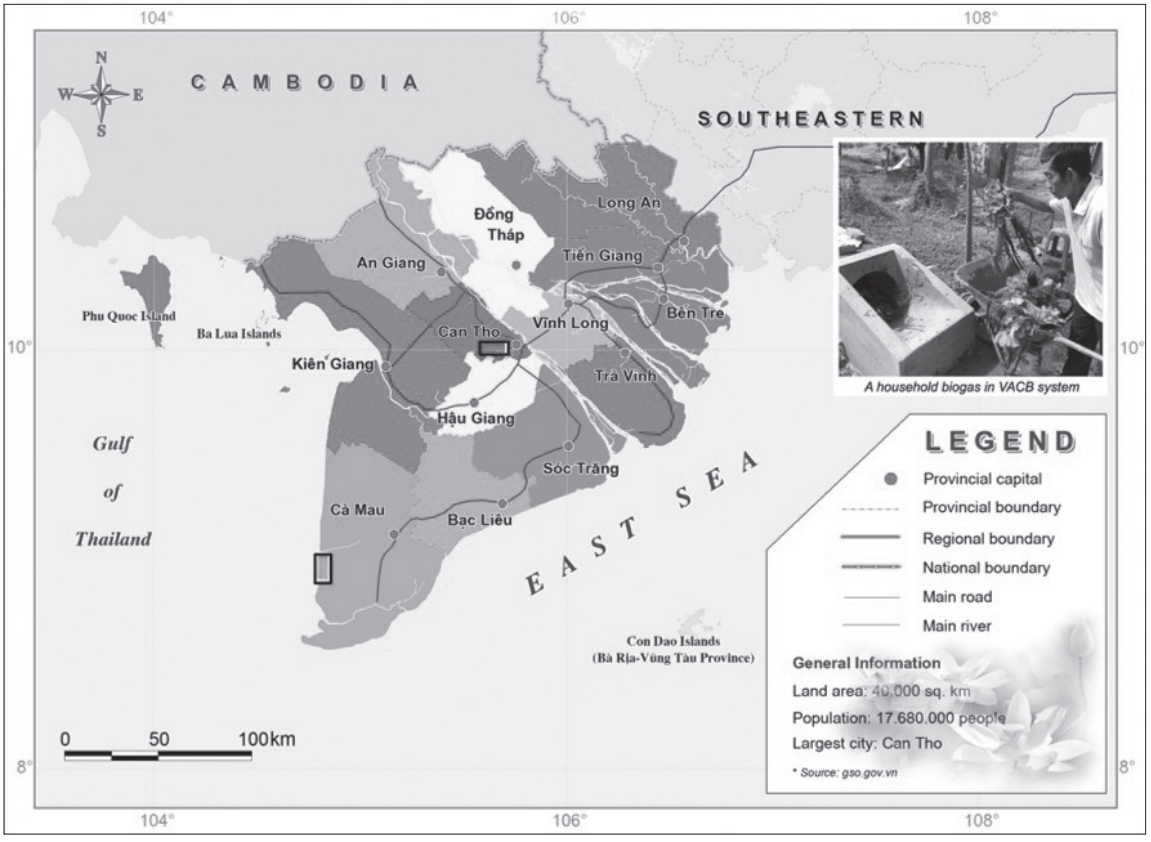
from 2013 to 2017 and when the support from Can Tho University likewise weakened due to other external economic shocks (Table 1).

T-learning in Disaster-Prone Areas: Narratives from Mekong Environment Forum Project

The local communities' lack of knowledge of environmental changes and more climate-resilient farming techniques is another obstacle to a sustainable transition away from traditional farming practices toward climate-resilient development models. Likewise, their lack of capacity building strategy impedes the government's climate-response policy and community efforts in coping with environmental changes in the Mekong Delta. In response to this well-established fact, the Mekong Environment Forum (MEF)[1] has implemented a nonprofit project called the "Flying Cranes Project" to build and develop community capacity in response to the intertwined threats facing the Mekong Delta, namely, water pollution, extreme weather conditions, and local non-sustainable economic activities. The project is supported by the US Consulate in Ho Chi Minh City through a sub-grant from the Stimson Center's Southeast Asia Program. It brought together experts, local farmers, youth, and other stakeholders in an attempt to address the said threats to the delta.

[1] The Mekong Environment Forum (MEF) is a local NGO that aims to prevent destructive projects from destroying the delta and to shape policies that will contribute to building a more sustainable and safer Mekong Delta.

Figure 2. Areas of study (marked as black rectangles) in the Mekong Delta



The project was implemented from March to October 2018 and aimed to build and develop community capacity in response to environmental changes. The project implementers accomplished this goal through learning-by-doing and adult learning (T-learning) approaches, which have been taught through a series of "citizen science training workshops." To meet those objectives and promote grassroots sustainable transition, MEF implemented the following activities:

1. Five experts and eight volunteer students from Can Tho University worked together to teach local farmers and the youth new farming technologies, and then mobilize them to use these techniques in their day-to-day work. The goal was to gradually shift the participants' livelihoods from traditional farming practices to a modern, eco-friendly agricultural model that could meet people's economic needs without degrading local ecosystems or increasing social disorder. A total of 20 small-scale shrimp farmers in Phong Dien commune (a coastal commune in Ca Mau province) had been selected to engage in T-learning under the supervision of experts and volunteers.
2. The project established a 2-ha sample field/demonstration site in the commune that showcased a climate-resilient polyculture model. This model enabled the farmers to diversify their crops, shifting from intensive shrimp production to polycrop in the same pond. This helped to increase household income and promote economic self-reliance, since farmers were able to harvest different profitable crops (e.g., seagrass, fish, crab, etc.) daily while waiting for the main crop (shrimp) to be harvestable. The

polyculture model encouraged the farmers to restore mangrove cover in the shrimp ponds in order to reduce the impacts of extreme weather events (e.g., high temperatures and cyclones); increase the local ecosystem's ability to absorb waste; and offer natural food and shelter for naturally occurring harvestable species (e.g., oysters, shrimps, fishes, and crabs).

At the demonstration site, the experts supervised the landowners in adopting sustainable farming. Meanwhile, the other smallholders were invited to visit and observe how the new techniques worked, how the restored seagrass and mangroves naturally purified the water, and how the polyculture improved revenues through the add-on crops. Three field-based meetings had been organized at the sample field—a kind of informal school where the participants met regularly to share information, make regular field observations, and learn new techniques by doing.

The farmers were then asked to compare what they learned from the field-based school with their own experiences. This is to better understand how eco-friendly farming practices have enabled them to reach a long-term balance between nature and economic return. Most participating farmers agreed that the mangroves and seagrass had helped to reduce their spending on food for shrimp and fertilizers for water treatment. They also learned that adopting polyculture can be less productive than what they had expected. However, it still demonstrated the potential to offer much more stable and sustainable income sources than traditional shrimp farming would.

The polyculture model can be a solution to the ecological conflict between mangrove conservation and shrimp farming in the Mekong Delta coastal provinces. The participants' responses provided feedback to the team of experts and contributed to revisions of the model that would help this approach to be more effective if applied elsewhere. The process also provided useful field experience for experts and students and will contribute to their professional development and future research.

Results and Discussion

Community pertains to a web of interactions among the environment, economy, and society. Hence, any approach to sustainable community development must consider the harmonious solutions that would enable humans to meet their present demands without doing harm to the other aspects (e.g., natural resources and cultures) and "without compromising the ability of the future generations to meet their own needs" (WCED 1987). Conceptually, Sattanno, Swisher, and Moore (2017, 1) envision and argue that a sustainable community is "a community where the air and water are clean, water supplies fully meet demand, everyone enjoys access to locally supplied safe and healthy foods, wildlife flourishes, and the landscape is pleasing to the eye. Within this community, full participation and a spirit of cooperation pervade decision-making."

In other words, a sustainable community can be seen as one that meets the needs of its residents, enhances and protects its environment, and promotes a more humane local society within its boundary.

Bridger and Luloff (1999), Fonchingong and Fonjong (2003), and Mezirow (2009) suggest five major indicators for measuring sustainable community development: (1) economic diversity and resilience, (2) grassroots self-reliance, (3) energy and environmental security, (4) biodiversity conservation, and (5) social justice. This paper uses the first four out of the indicators as an analytical toolbox to understand the ways by which T-learning has significantly contributed to local sustainability transition in the two study areas.

T-Learning Helps to Increase Local Economic Diversity and Resilience

In the Flying Cranes Project, the project team organized two training workshops in Phong Dien commune (March 2019 and May 2019) to raise awareness about environmental changes, water insecurity, and sustainable development concepts among local community members. Before each workshop, the team had carried out surveys to collect information and understand the urgent

local needs. After completing the workshop, the participants were asked to fill out a questionnaire with closed and open questions. Our comparison of the survey results from before and after the workshop indicates that the locals' awareness of the role mangroves play in environmental protection and local water security significantly improved. Below are some measureable outcomes excerpted from the project report (MEF 2018):

1. *About 35 percent increase in productivity and economic efficiency*
2. *Comparatively higher levels of income and economic diversity.* After participating for four months, the farmers were able to harvest three different crops from the same pond—crab, shrimp, and fish. The average income per monoculture crop (four months) of each household before participating in the project was 12.6 million Vietnamese Dong (VND) (approximately USD 560). The average income after the farmers harvested their first polyculture crop in early September 2018 was VND 17 million (approximately USD 756). With the polycrop, the farmers can then harvest some kind of fish inhabiting the mangrove and seagrass in the shrimp pond on a daily basis. The fish species are natural inhabitants from the river and grow up by themselves owing to the food and habitat provided by the mangrove and seagrass.
3. *Cost savings and additional revenues*. In a traditional four-month monoculture crop, a 1-ha shrimp pond needs VND 4.5–6.0 million (approximately USD 200–300) for fertilizers and pesticides.
4. *Mangrove, seagrass, and new techniques improve the water quality.* These factors reduce the costs for fertilizers, wastewater treatment, and preventing common diseases. Participating farmers have invested VND 1.3–2.0 million (less than USD 100) per polyculture crop for fertilizers to stabilize pH and water quality in response to weather uncertainties.
5. *Shrimp as the main crop, whereas harvesting crab, seagrass (bulrush), and fish from nature provides additional daily income* for shrimp pond owners while they await for the shrimp being cultured to grow.

As for the VACB system, the research team conducted three household surveys and in-depth interviews. The surveys were done from October 2017 to December 2017, whereas the in-depth interviews were conducted in September 2018. A total of 120 VACB farmers participated in the surveys. The areas covered in the data collection encompassed four communes of Phong Dien district, namely, Truong Long, Nhon Nghia, Giai Xuan, and My Khanh (Figure 3). The surveys included questionnaires with closed- and open-ended questions designed to collect quantitative and qualitative data on the household level impacts of the VACB project in terms of economic, energy, environmental, and sustainability areas.

On the other hand, the in-depth, semi-structured interviews were done with 80 VACB farmers, including women and ethnic Khmer, and 35 non-VACB neighboring farmers whose feedback and data were used as a control.

Tables 2 and 3 compare the annual incomes generated from VACB with those from traditional crops. VACB farmers doubled their family incomes because they diversified income sources from main and add-on crops. Given this, most VACB families are no longer at risk of accumulating debt or be forced to move to urban areas for wage labor. A family survey showed that those VACB families have not relied on remittances from their family members who seek employment in factories (Table 2). Also, the added family income enabled many VACB farmers to support their children's higher education or professional development needs.

Crop diversification through the VACB system also enables farmers to proactively choose crops or animals that adapt to new conditions (such as unexpected drought or price drops). Likewise, the system significantly reduced their working time in the fields because the system is entirely closed. This implies that the VACB farmers "bring in nothing from outside of their farm, no

Figure 3. Distribution of VACB system by commune in Phong Dien district

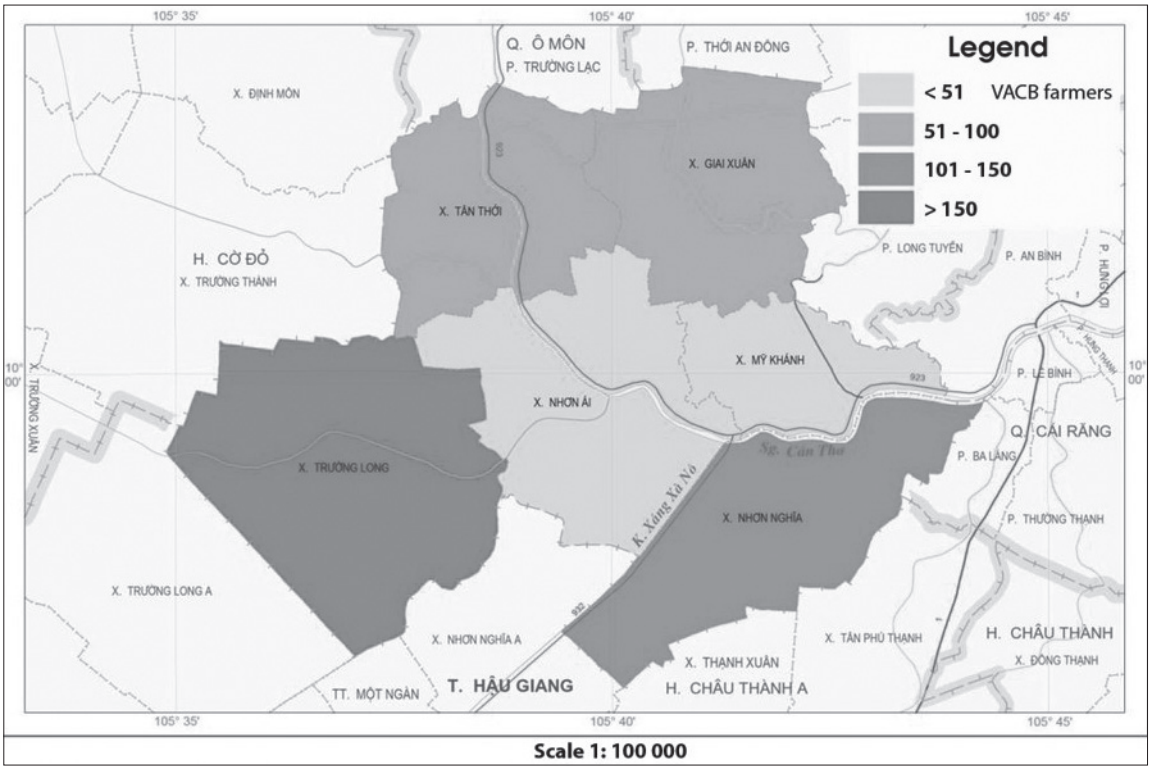


Table 2. Common VACB crops and average household income in Phong Dien district

System Components	Crops		Average Revenue (in VND million)	Shares to Family Income (%)
	Main Crops	Additional Crops		
Orchard (5,000 m^2)	Orange		22	13.0
	Mengteng		16	9.5
	Pomelo		11	6.5
		Vegetables	4	2.4
Fishpond (1,000 m^2)	Snake fish		15	8.9
	Bronze featherback		12	7.1
	Red tilapia		12	7.1
		Snail	13	7.7
Pigpen (10 pigs)	Pig		42	24.9
		Chicken/duck	8	4.7
Biogas	Methane gas*		14	8.3
Sub-total			169	100
Other income sources				
Temporary work (seasonal income-generating jobs)			–	–
Remittance from family members			–	–
Total			**169**	**100**

Notes: * Using methane gas for family cooking, irrigation, and lighting helps a six-member VACB household save approximately VND 14 million by reducing the need for commercial gas and electricity each year.
n = 120

Table 3. Average annual incomes with traditional crops in Phong Dien District

Income sources	Average Revenue (in VND million)	Shares to Family Income (%)
Rice farming	26	35.6
Temporary work (seasonal income-generating jobs)	8	11.0
Remittance from family members	24	32.9
Poultry farm	15	20.5
Total	**73**	**100.0**

Note: Pre-project household survey and in-depth interviews in 2017 (n=120) and interviews with non-VACB farmers in

pesticides, fertilizers, or antibiotics to maintain its productivity" (Eyler 2019).

VACB farmers in Phong Dien stated that their daily life now includes feeding their livestock, tending their orchards, and filling biogas digesters with pig dung, water cabbage, or biomass. "We really enjoy this farming model, and maintaining the system doesn't require a lot of work. Now, the system can take care of itself. Sometimes, I don't have to tend to it for a few weeks," said Mr. Le Hoang Thanh, one of the proudest and most ingenious VACB farmers in the Mekong Delta.

The participants helped the university experts to train other monoculture farming households in making the transition. They were also invited to conventional events, workshops, and TV talkshows to share their success stories.

On the contrary, Table 3 shows that those farmers who maintained traditional monoculture (rice farming) earned less revenue and frequently appeared unable to cope with changing weather conditions or price drops in the market since they have less crop alternatives. Facing seasonal food and income shortages each year, many rice farmers, especially women, are constantly looking for temporary, poorly paid work or other income-generating activities. The household survey in Phong Dien district reveals that in monocrop families, especially those whose farming land area is less than half hectare, young family members often have to migrate to big cities or industrial zones in search for jobs. Monthly remittance from those migrant workers represents almost one-third of their family annual income (Table 3).

The outcomes from the VACB and the Flying Cranes Project demonstrate that T-learning approach causes gradual, yet profound, changes in the local people's perceptions and farming practices. Local climate action and sustainable transition are uncommon in the Mekong Delta. The Diplomat (2017) reported that with almost 80 percent of the Mekong Delta's population engaged in agriculture and fishery, the local people tend to be quiescent, given the traditional notion that the state leads, and all should follow. Many farmers remain very superstitious, overly protective, and not open-minded (Eyler 2019). This fact appears to challenge new ideas or solutions. Thus, T-learning was employed in these projects to help them understand the changing circumstances and find clear alternatives to sustain their livelihoods. Learning how to diversify their crops, replace old-fashioned farming habits, and adopt new techniques through field-based schools helps to broaden local farmers' options in building resiliency to both climate uncertainties and economic shocks, while generating comparatively higher levels of income.

T-Learning as a Tool for Building and Sustaining Community Self-Reliance

The basic indication of sustainability is self-reliance, especially economic self-reliance (Bridger and Luloff 1999; Fonchingong and Fonjong 2003). A community demonstrates its self-reliance by showing that its members are confident and have the capacity and skills to accumulate and manage economic resources to meet their essential needs in a sustainable manner (The Hunger Project undated; Godfrey 2008). The measure of community self-reliance is based on a diverse set of indicators, which are grouped into five clusters: (1) economic inclusive development; (2) gender equity and women empowerment; (3) water and energy security; (4) community education; and

(5) community climate resilience. These five clusters and attendant component indicators were designed in accordance with the Millennium Development Goals (MDGs) and, subsequently, the Sustainable Development Goals (SDGs).

Table 4 outlines the progress that the VACB communities in Phong Dien district have made in the given self-reliance indicator clusters. The targets were set to clarify what is meant by "demonstrated progress", and to clearly state expectations.

Given the figures shown in Table 4, the VACB communities in Phong Dien district have achieved two-thirds (17 out of 25) of the targets set to demonstrate their self-reliance. The self-reliant VACB communities have also demonstrated progress in the key goals that constitute the MDGs and SDGs, as follows:

1. Mobilized communities that continuously set and achieve their own development goals (Cluster 1)
2. Empowered women and girls (Clusters 1 and 2)
3. Improved access to safe drinking water and sanitation facilities (Cluster 3)
4. Improved literacy and education (Clusters 1 and 4)
5. Improved gender-equal access to and use of development resources (Clusters 2, 3, and 5)
6. Improved land productivity and climate resilience of smallholder farmers (Cluster 5)

When the VACB communities achieve the targets for self-reliance, the VACB project gradually activates its exit strategy by reducing financial inputs and scaling down the supporting activities, with the exception of less-frequent staff visits and a post-project evaluation 3–5 months later in a select number of locations. Given that community leadership plays a key role in aiding the continuity

Table 4. Measuring VACB community self-reliance in Phong Dien district

Cluster	Component Indicator	End Target (Locally Set Target)	Current Progress
Economic inclusive development (MDG 1 and SDGs 1, 2: No poverty – No Hunger)	Proportion of community members are trained in income generating or livelihood activities	60-70%	63%
	Proportion of population participating in community activities, workshops, and meetings	50%	44%
	Number of community facilitators supported by local government	10 per commune	10 per commune
	Proportion of individuals reporting the ability to change their communities	10 per commune	10 per commune
	Proportion of population garnering economic surplus (revenue exceeds costs)	80%	88%
	Proportion of ethnic minorities being benefited from the project	60-70%	83%
	Proportion of project participants reporting the ability to meet their economic development goals	100%	100%
	Number of female trainees in workshops	45-50%	37%
Gender equality and women's empowerment (MDG 3 and SDG 5)	Proportion of women serving as T-learning group facilitators	30-40%	40%
	Family decision-making power	equal power	equal power
	Proportion of women supported by the project	45-50%	37%

Continued on next page

Table 4 continued

Cluster	Component Indicator	End Target (Locally Set Target)	Current Progress
Household water and energy security (MDG 7 and SDGs 6, 7)	To what extent communities are satisfying their household water and sanitation needs and improving hygiene for public health	3.0 (capable) 4.0 (effective)	3.0 (capable)
	Proportion of households applying modern wastewater treatment system introduced by the project (reduced household wastewater discharge)	100%	68%
	Households are able to generate electricity from renewable energy sources to meet their household basic needs (lighting, cooking, and irrigation)	Yes	Yes
	Decrease in purchasing household electricity from national power grid	Yes	Yes
	Decrease in commercial gas consumption	Yes	Yes
Community education	Proportion of community members trained in thematic workshops	60-70%	40%
	Proportion of households with at least one person mastering in VACB-related techniques and skills	50%	40%
	Intra-community information-sharing platform (social networks, smart phones, mobile apps, etc.)	Frequent	Frequent
	Community awareness of climate change effects and environmental issues	High	High
Community climate resilience (MDG 7 and SDGs 13, 15)	Misconception of climate change	No	No
	Proportion of population trained in food security and sustainable agriculture	60-70%	40%
	Proportion of households trained cost-benefit analysis	50%	40%
	Proportion of smallholders applying improved management practices and technologies on farms	60-70%	40%
	Presence of climate-resilient demonstration field in each commune	Yes	Yes

Note: Household survey and in-depth interviews in 2017 (n=120)

and development of grassroots innovations, which operate in niches and require nurturing, the project's exit strategy also emphasizes training on community leadership and management.

Before this milestone was achieved, local communities had gone through a transition period. The T-learning workshops were the key activity implemented to introduce new ideas and solutions without inciting doubt, dismay, or concern. The workshops targeted local farmers, women, and ethnic minority representatives, many of whom are relatively conservative and not open-minded. For many years, local farmers have experienced noticeable changes to their environment (e.g.,

rising temperatures, irregular flooding and droughts, and environmental degradation), which have adversely affected their crop productivity.

During one of the training-workshops of the project, Lam Thi Suol, 41, an ethnic Khmer farmer in Phong Dien commune, explained how she and her neighbors have been experiencing environmental changes in their village. "It seems to be almost twice hotter than it was 10 years ago. Drought season seems to last longer and longer with uncertain, unpredictable precipitation. In the past, we could drink water directly from rivers or pools while working in the ricefields. But in recent years, you see, the rivers get heavily contaminated due to saline intrusion, so we have to stop using this major water source, even for irrigation," she said.

Suol is among the millions of farmers and fishermen in the Mekong Delta who completely rely on the waterways' fish resources and agricultural production for their subsistence. They have observed the changing circumstances over many years. With very low literacy rates, however, they were unable to understand the root causes of the problems they have been facing. As a result, they have failed to search for a sustainable and resilient model that they could adapt.

Thus, a series of T-learning workshops were regularly organized to build confidence, capacity, and skills at the household and community levels. Suol and 650 other farmers in Phong Dien district (Can Tho City) and Phong Dien commune (Ca Mau province) had been invited to attend these workshops.

The T-learning activities in the VACB and the Flying Cranes projects demonstrate that changes in livelihood constitute a process of transformation. The trainees (or T-learners) have gradually accepted to change their mind, perception, attitude, and confidence through new experiences. During the workshops, emerging environmental changes and challenges appeared to serve as a "disorienting dilemma" that forced T-learners to reconsider their traditional perspectives and farming habits. Since most training workshops took place in local fields (orchards, fishing ponds, pastures, paddy fields, etc.), they can be described as field-based schools—a kind of institutional platform where participants (i.e., farmers and experts) meet regularly to share information, conduct regular field observations, and learn new techniques by doing. Local farmers are expected to compare their past experiences with what they have learned from the field-based schools. In such a way, they will be able to pursue eco-friendly farming practices, thereby enabling them to meet economic needs without degrading local environment. In this T-learning process, the local farmers were asked to work in groups in accordance with their expertise, interests, and geographical proximity.

More than 12 professional courses have been offered by CTU experts on the different VACB-related topics. The courses include horticultural diversification, swine farming techniques, swine disease prevention and treatment, fish hatching and fish stock management, biogas plant construction and maintenance, among others. Each training course had been structured around a theoretical component followed by practical session component and lasted 1–3 days or longer. Around 30-40 farmers, women, and ethnic minority representatives enrolled in the training. A few outstanding trainees from these courses were appointed to work as group facilitators to sustain and to lead T-learning activities after the project had been completed.

T-Learning Promotes Household-Level Energy and Environmental Security

The third sustainability dimension stresses energy and environmental security. This means that "the use of energy and material is in balance with the local ecosystem's ability to absorb waste" (Bridger and Luloff 1999, 381). The VACB model in the Mekong Delta is a clear example of this. In the VACB system project, T-learning workshops were organized to provide the local farmers with techniques and knowledge to effectively use electricity, while correctly managing the waste from agricultural activities, such as straw, muck, biomass, etc. for household-level energy generation.

Since its inception until 2017, the VACB project has assisted local people in building 642 biogas digesters (Table 1). The project also organized pre- and post-installation training seminars to circulate digester building techniques. The Viet Nam News (2014) reported that recent research findings estimate that a 2 m^3 bio-digester can reduce up to 3 tons CO_2. Moreover, each household using biogas can save 19,904 tons CO_2 equivalent per year due to displacing wood fuel and lowering deforestation in local forest.

The T-learning approach was also employed to promote behavioral changes essential to realizing the full benefits of bio-digesters. For generations, rural women have always completely relied on firewood for the household's daily cooking. The traditional fuel, mostly collected from the forest, is a free energy source for local residents. Meanwhile, biogas installation usually costs a family an average of VND 3.0–5.5 million (USD 130–250), depending on the biogas container size. Nonetheless, the results of the household survey in December 2017 show that using biogas for family cooking, irrigation, and lighting purposes helps VACB farmers save up to VND 14 million (USD 600) each year by reducing their need for commercial gas and electricity (Table 2). Thus, T-learning workshops had been carefully designed to introduce bio-digesters as a clean, reliable and cost-effective source of power. In these workshops, the project implementers invited farmers, who have successfully implemented the biogas system, to share their experience and cost-benefit analysis. Their success stories paved the ideal way to present and justify the significance of biogas. The participating farmers were asked to compare their traditional fuel use with what they had learned from the field visit to the biogas systems in order to better understand how the new solution matters. As such, the T-learning activities were able to build credibility and support for a new direction.

T-Learning and Biodiversity Conservation

A sustainable community is underpinned by biodiversity conservation and wise stewardship of natural resources, and this is partially related to the third dimension. The narratives gathered from the Flying Cranes Project are analyzed in this section to clarify how T-learning contributes to fostering this sustainability dimension.

Sea level rise and saltwater intrusion into farmlands have become more rampant in recent years. Consequently, an increasing number of rice farmers in the coastal areas of Ca Mau province are switching to shrimp farming as a way to sustain their livelihood. Many small-scale shrimp farmers prefer intensive farming due to the higher yield that such system provides. Intensive shrimp farming, however, harms the local ecosystems as the method encourages overusing chemicals to maintain water quality. It also promotes mangrove clearance to enable farmers to expand their shrimp farm area (Anh et al. 2010; Truc et al. 2018). Local governments and greedy economic interests are keen to boost this high intensity and artificial style of shrimp farming. However, ecological conflicts are emerging due to intensive farming. The shrimp farming industry, therefore, has become a new threat to the years of economic progress in Vietnam's newfound strength (Quang and Weatherby 2019). In a clash between intensive shrimp farmers trying to expand their business at all costs and the need to protect and preserve the local ecological riches, conservation and stability is clearly losing.

The Flying Cranes Project was designed to help to address these conflicts. The pre-project survey highlighted that before the local farmers participated in the project, they had built intensive shrimp ponds and had invested heavily on the construction of these ponds, with most of the money coming from bank loans. Likewise, the farmers spent huge amount on food for the shrimp, medicines, fertilizers, and other chemicals to use in the pond to ensure productivity. Moreover, mangroves were cleaned to provide more space for shrimp farming. Also, the local people opined that the tannic acid extracted from mangrove trees is poisonous and harmful to their shrimp productivity. Overusing fertilizers, medications, and chemicals has negatively impacted the local environment and has caused serious water pollution and soil quality deterioration (Anh et al 2010; Truc et al 2018). As a result, the local farmers were unable

to sustain their shrimp ponds due to the frequent epidemic diseases caused by low water quality and to the changes in weather patterns. After years of borrowing money yet failing to harvest, many shrimp pond owners had no choice but to sell their land to pay off their debts. They consequently migrated to big cities in search of off-farm jobs because they were unable to make ends meet with traditional shrimp-raising methods (MEF 2018). In response to this situation, local governments in the delta have implemented a conservation program that requires any farming activity to meet the environmental standards and prohibits mangrove clearance. However, The Mongabay News (2018) reported that most shrimp farmers are reluctant to change their practices unless they have hit rock bottom.

The educators of the Flying Cranes Project training workshops in Phong Dien commune (Ca Mau province) raised the visibility of the deplorable environmental, economic, and human rights impacts of unsustainable development projects and old-fashioned farming practices as well as the viability of better options. They provided information on a wide range of water and energy issues. Also, they worked to make the participants more aware that efficiency and small-scale, decentralized, and eco-friendly solutions are essential to meet economic needs, alleviate poverty, and protect local ecosystems. The polyculture—an integrated farming system of shrimp, mangrove, and natural marine species—was introduced and employed in a sample field in the commune.

The combination of using mangrove, seagrass, and polyculture techniques appears to be a viable alternative to help local community to meet their economic needs and to maintain their livelihoods while reducing pressure on ecosystems. Significant reduction in fertilizer and chemical use reduces the accumulation of polluted wastewater in shrimp ponds (Tables 5 and 6). Mangrove and seagrass help to naturally purify the water and filter the pollutants from the ponds.

The farmer-participants also learned that fish and sick shrimps are also major food sources of crabs. Without crabs in the pond, some ill shrimps could fuel a possible epidemic that can wipe out the whole shrimp pond. However, if crabs are present in the pond, they will eat the sick shrimps, and thus help to prevent outbreaks. The farmers, therefore, have concluded that the polycrop method is less risky than intensive shrimp for outbreaks. All pond owners discharge wastewater directly into the river, which is the major water source for the whole village. Hence, switching to a polyculture model is an important investment not only for farmers but for their communities.

Table 5. Pollution caused by intensive shrimp farming in the Mekong Delta

Indicator	Measured		Per Ton of Shrimp (Average 3.5 t/ha)	
	Value	Unit	Value	Unit
Wastewater	18,260 – 22,640	m^3 ha/year	5,300–7,200	m^3/ton
BOD content	1,082	mg/L	259	kg/ton
COD content	1,866	mg/L	769	kg/ton
TSS content	6,524	mg/L	1,170	kg/ton
Total N content	49.6	mg/L	30	kg/ton
Total P content	23.8	mg/L	3.7	kg/ton
N-NH^3 content	14.3	mg/L	4.8	kg/ton

Source: Anh et al. (2010); Truce et al. (2018)
Notes:
BOD = biochemical oxygen demand; COD = chemical oxygen demand; N-NH^3 = ammonium nitrogen; P = Phosphorus; N = nitrogen; TSS = total suspended solids

Table 6. Average water quality observed and calculated in different periods of polyculture farming

Indicator	Pollutant Load		Vietnam Standards (QCVN 11-MT:2015)	
	Value	Unit	Value	Unit
Wastewater*	0	m^3/ha/crop	0	m^3/ha/crop
BOD content	0.032	kg/m^3	0.039	kg/m^3
COD content	0.081	kg/m^3	0.117	kg/m^3
TSS content	0.102	kg/m^3	0.16	kg/m^3
Total N content	22.71	g/m^3	48	g/m^3
Total P content	10.32	g/m^3	15.6	g/m^3
N-NH^3 content	0.08	g/m^3	0.1	g/m^3

Source: MEF (2018)
Notes:
BOD = biochemical oxygen demand; COD = chemical oxygen demand; N-NH^3 = ammonium nitrogen; P = Phosphorus; N = nitrogen; TSS = total suspended solids
*Normally, the water used in polyculture farms is reused for the next cropping season. No wastewater, therefore, is discharged into rivers.

A few weeks after the local farmers participated in the training-workshop, the project team came back to assess how well they were able to apply the new knowledge, techniques, and skills they had learned to their work and life. The project implementers recognized that the local farmers have begun to change their perceptions and habits. Some tried to sustain the last piece of mangrove in their ponds, whereas others agreed to diversify their crops by growing high-yielding marine species. They also began using water monitoring techniques more frequently to observe the water quality of both river and groundwater. Now that the farmers understand the negative impacts of the wastewater discharged from the neighboring intensive shrimp ponds, some farmers raised their concerns about the current policy that encourages intensive shrimp farming. They feel that the policy lacks serious consideration of the environmental implications.

The progress from the Flying Cranes Project demonstrates the role that T-learning plays in transforming local perspective and traditional practices. New ideas are often associated with difference, change, and upheaval, especially when introduced into a well-established community culture. In Phong Dien commune, the shrimp farmers traditionally perceived mangroves as an "enemy" of shrimp productivity. Likewise, intensive shrimp farming remains most preferred in this commune since its potential earnings are higher in this industry. As such, the local residents of Phong Dien are less likely to be persuaded to reforest in their shrimp ponds. Thus, the positively changing perspective and habits of farmers engaged in the Flying Cranes Project demonstrates that the T-learning workshops and attendant real-life experience can be an effective strategy to mobilize and support local farmers to transition to more harmonious agricultural paradigms.

The abovementioned results and analyses reaffirm an important argument of this paper: T-learning can be an appropriate form of sustainable education since it provides adult learners with unique learning opportunities to gradually change their perspectives and behaviors through real-life experiences in on-the-ground activities. The projects have demonstrated that T-learning is an effective educational approach to sustainably change communities that remain overly protective and reluctant to embrace innovative strategies.

T-learning activities are designed to utilize and combine tacit knowledge (e.g., ability to work), modern techniques, and community leadership in order to empower the local people to change and respond to their concerns in proper, sustainable,

and impactful manner. In the T-learning process, the smallholders are the individuals who learn to change themselves, and then circulate their new experiences to inspire and facilitate their neighbors to change. As the progress of T-learning has formed a nexus of multistakeholder relationship (e.g., local farmers, academics, policymakers, enterprises, and investors), individual changes quickly increase the likelihood of a broader social change being sparked by interacting with other stakeholders and actors in the nexus.

T-Learning in Sustainable Transition: Impediments and the Role of Students

The results of the VACB and the Flying Cranes Project outline some issues and emerging challenges that need to be addressed in order to upscale T-learning activities across the Mekong Delta. The focus group discussions and in-depth interviews conducted in this study with 120 T-learning farmers in October 2017 and December 2017 highlight a number of factors and barriers that are obstructing the transformative process in the grassroots communities. Table 7 outlines these factors.

Table 7. Major factors and issues challenging the development of T-learning

No.	Factor Description	Frequency (No. of Respondents)
1	Lack of financial and technical supports	107
2	Lack of facilities for community learning	83
3	Policies and supports from local government	57
4	Poor commitment (farmer learners may stop pursuing the grassroots innovations whenever they find other solution which they believe can bring them higher potential earnings)	42
5	Lack of intra- and inter-community information sharing	28

Note: n = 120

The first main challenge to the continuity and expansion of T-learning-based projects is the limited support from donors (e.g., universities, financial institutions, donor agencies, etc.). Almost 90 percent (n = 107) of the respondents argued that they need seed funding, technical training, and other skills to shift from traditional practices to the new mode of livelihood. In order to help the farmers who participate in the T-learning projects, financial and technical support and the number of training activities need to be increased since these are crucial components in addressing the problems that remain in local communities, especially those in the disaster-prone areas.

The second challenge is the lack of infrastructure to facilitate community learning (n = 83). T-learning farmers live in rural villages where the means of communication and transportation remain limited or outdated. Many villages do not have adequate public spaces for community learning activities. As a result, T-learning workshops in the Mekong Delta often take place in the homes of farmers, where proper materials and equipment for training (e.g., blackboards, flipcharts, office supplies, and projectors) are not available. Additionally, both the homeowners and participants usually find this arrangement uncomfortable.

Policies and support from local authorities also play an important role. A total of 57 farmers (47.5%) pointed out that although the T-learning process has promoted sustainability transition and poverty reduction in communities, local government authorities remain passive; hence, they have not fully embraced the T-learning initiatives. This explains why local government budgets are not reallocated to fund community learning centers and to support training workshops. Consequently, T-learning project organizers have no choice but to apply for limited funding from donors and sponsors (e.g., donor agencies) and for university research grants.

Another challenge that needs to be addressed is the farmers' lack of commitment toward T-learning projects. About 35 percent

(n = 42) of the respondents contend that they might stop following the farming practices introduced by T-learning activities in order to try other solutions if they see that the alternative can bring in higher potential earnings. This can lead to disruption and waste of supportive inputs offered by T-learning projects.

The fifth barrier impeding the upscaling of T-learning activities is the lack of information shared between T-learning farmers and their neighbors, and between farmers and experts, and the lack of intercommunity communication. Smartphones, internet-based social networks (e.g., Facebook, Zalo, YouTube, etc.) and online resources are the most popular and convenient methods of communicating and sharing information. About 23.3 percent (n = 28) of respondents said that they do not have a smartphone and are not familiar with those social networking apps and websites. They also find it difficult to learn and apply new techniques, especially those that require technological equipment (e.g., mobile sensors), to share their experience and fieldwork results with their neighbors, local experts, and other communities at large.

To that end, the T-learning projects have spotted many group participants who are young, well-educated farmers and university students. They have served as a bridge between local farmers and experts by helping both parties to communicate their concerns and to share solutions. They have also helped to connect local T-learning groups with international communities, including academic institutions and journalists. Some T-learning demonstration sites and participants, like Mr. Le Hoang Thanh, have been widely recognized in books, PhD dissertations, and international magazines. Thus, local youth and students become the best choice to take over this position in T-learning projects.

Unfortunately, young people's participation remains limited in the grassroots T-learning process in the Mekong Delta. Young farmers and students are the next generation in communities who will succeed their family's farming livelihood or leadership. They typically have greater access to higher education than previous generations, and they keep themselves well informed of the latest technological developments.

As the local youth and students are likely to shoulder the negative impacts posed by present-day developments, it is vital that they assume an increased role in the grassroots T-learning process. Furthermore, engaging in T-learning projects offers local students ample opportunity to employ what they have learned in school such that they can assist their community. The real-life experience from the demonstration sites, in turn, provides best "disorienting dilemmas" and aspirations for their self-reflection, self-adjustment, and changes. Without such a connection between grassroots T-learning and school-based T-learning, students may not effectively promote the transforming process.

Conclusions

This paper presents and examines a new adult education approach (i.e., T-learning) that emphasizes grassroots sustainability where local knowledge and efforts are essential, and where changes can be seen and felt more immediately. The findings of this study may be summarized as follows.

First, in disaster-prone regions such as the Mekong Delta, the increasing environmental injustices created by the adverse impacts of climate change associated with ill-conceived development projects appear to serve as a prominent "disorienting dilemma", thereby forcing local individuals (e.g., farmers, women, and ethnic groups) to learn to shift their traditional farming practices and lifestyle choices to align with a low-carbon and mode of livelihood that is climate-resilient.

Second, there are many ways to implement climate-resilient polyculture systems (e.g., VACB and mangrove-based shrimp farming systems). What works for farmers in Phong Dien district (Can Tho City) might not be replicable in Phong Dien commune (Ca Mau province) or in other parts of the delta due to various physical and socioeconomic features. However, the design and impacts of T-learning processes employed in those models are completely alike. This demonstrates

that T-learning should be acknowledged as an adult-learning approach that allows grassroots innovation implementers to introduce new ideas and accordingly mobilize local people to make changes without inciting doubt, dismay, or concern.

The success and upscaling of the T-learning process may have been influenced more by adult education strategies used than by different innovative ideas or geographical conditions. Adult education strategies include, but are not limited to, initial seed funding and technical training, technology transfer, community leadership building, improved participant commitment, among others. Support from local policymakers also plays a role in upscaling and achieving more widespread adoption outside of their local, sustainability niche.

Third, the analysis and assessment of grassroots innovations implemented in the Mekong Delta provide field-based evidence to support the existing argument that T-learning works as an appropriate ground-up approach to sustainability, broadly contributing to climate-resilient development in vulnerable communities. In this respect, the paper identified and documented four major indicators that measure sustainable community development, in which T-learning has significantly contributed in the research sites. These indicators include economic diversity and resilience, grassroots self-reliance, energy and environmental security, and biodiversity conservation. T-learning provides the recipients with unique learning opportunities through real-life experiences in on-the-ground activities.

The study also argues that the extent by which grassroots sustainability becomes a reality will depend on "field-based schools" that offer real-life experiences and ample opportunity for farmers to learn and gradually change their perspectives and behaviors.

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