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The Lawa model: A sustainable, integrated opisthorchiasis control program using the EcoHealth approach in the Lawa Lake region of Thailand

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ABSTRACT

Opisthorchiasis caused by the carcinogenic liver fluke *Opisthorchis viverrini* is a major foodborne parasitic zoonotic disease in Thailand and neighboring Mekong countries. The infection is associated with several hepatobiliary diseases including cholangiocarcinoma (CCA). The rates of CCA in regions where the parasite is endemic are unprecedented. Extensive research on various aspects of opisthorchiasis has been conducted in recent decades. However, the current status of *O. viverrini* infection in the country is approaching 85% prevalence in certain endemic areas even after more than 30 years of control programs in Thailand. The complex life cycle of the fluke, which involves several hosts/environments, makes it difficult to control by conventional methods. Therefore, a new control strategy using the EcoHealth/One Health approach named the "Lawa model" was introduced into the liver fluke endemic Lawa Lake region in Khon Kaen Province. This program has been underway for over ten years. The program includes treatment with anthelmintic drugs, novel intensive health education methods both in the communities and in schools, ecosystem monitoring and active community participation. We developed the "Liver fluke-free school program" as a part of the Lawa model with successful results. All key stakeholders were empowered to obtain competency in their control activities for the sustainability of the program in the community. Nowadays, the infection rate in the 12 villages surrounding the lake has declined to less than 10% from an average of 60% at the start. The *Cyprinid* fish species now show less than 1% prevalence of infection compared with a maximum of 70% during the baseline survey. No infected *Bithynia* snails in the lake were found during recent field studies. Of the lessons learned from the Lawa model, the importance of community participation is one practical and essential component. The key to the success of the project is multi-stakeholder participation with the active local Health Promoting Hospitals and the village health volunteers. The idea of the Lawa model is on the national agenda against liver fluke infection and CCA and is being scaled up to work in larger areas in Thailand. Internationally, the "Lawa model" is one of two programs that are showcased as successful control programs for helminths by the WHO Neglected Zoonotic Diseases (NZD4). Several media outlets have broadcast news reports about the program.

1. Introduction

Opisthorchiasis, a fishborne trematodiasis caused by *Opisthorchis viverrini* infection is a disease of poverty endemic in Southeast Asia, particularly in the Mekong countries. The life cycle of this liver fluke is complex, involving the *Bithynia* snail, the first intermediate host; the Cyprinid fish, the second intermediate host; and human and other mammals as definitive hosts (Fig. 1). The infection is acquired by eating raw or undercooked freshwater Cyprinid fish that harbor the metacercariae of the parasite, the infective stage of the liver fluke. The metacercariae excyst in the duodenum, migrate to the bile ducts in the liver and then into the extrahepatic bile duct where they mature. A month after infection, the flukes lay eggs in the bile that pass with the feces. Upon open defecation, the fluke eggs contaminate water bodies and are eaten by *Bithynia* snails. There are several stages of parasite development in the snails, from miracidia, to sporocyst, to rediae, and

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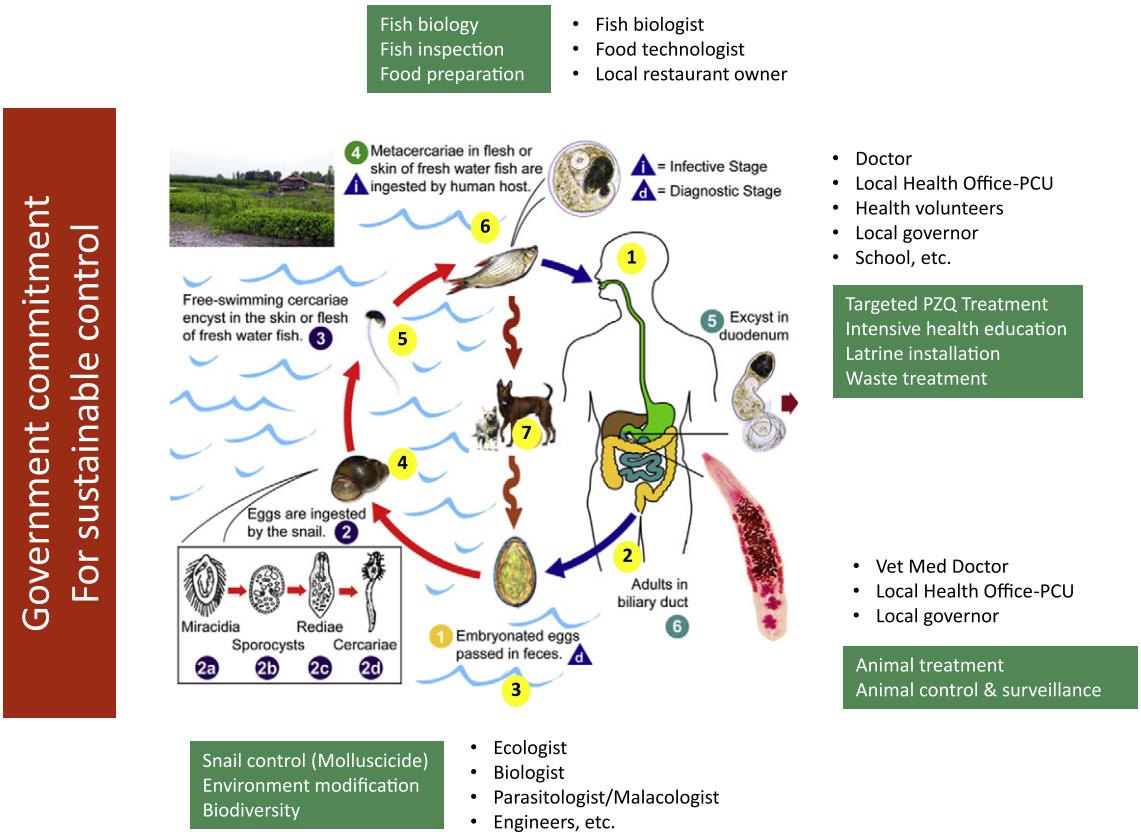

Fig. 1. Systems thinking on interruption of liver fluke transmission and sustainable control of the Lawa model.

finally to cercariae. The free-swimming cercariae exit the snail and penetrate and encyst in Cyprinid fish as infective stage metacercariae. People are infected by eating raw or undercooked fish, which completes the cycle. Liver fluke infection is associated with several hepatobiliary diseases including cholangiocarcinoma (CCA), a fatal bile duct cancer. The Lao People's Democratic Republic (Lao PDR), Thailand and Vietnam, where liver fluke is endemic, are among the top 10 countries in the world with the highest incidence of primary liver cancer [1]. Khon Kaen, Thailand has reported the highest incidence of CCA in the world. The best way to reduce the morbidity and mortality of opisthorchiasis and the associated cancer, is to control liver fluke infection.

However, control of the liver fluke is difficult due to its complex life cycle. Lessons learned from the past decades of liver fluke control in Thailand indicate the overall prevalence of the infection can be reduced in areas of low endemicity, but the disease tends to persist in areas of high endemicity [2]. Seven obstacles to successful control have been described so far by Sripa et al. [3]. Lack of real knowledge of the disease among people in the community is a major obstacle for effective and sustainable control. New system approaches for research and disease control, rather than government top-down policy, have been recommended for persistent helminth diseases [4]. Ecosystems Health or EcoHealth, an integrated approach to liver fluke control, has been successfully introduced into areas of Northeast Thailand endemic for opisthorchiasis during the past 10 years [3]. This integrated control program, now called the "Lawa model" is recognized nationally and internationally. This control model is one of the two showcases by WHO Neglected Zoonotic Diseases (NZD4) [5]. This review highlights the systems thinking of the "Lawa model" and shows our practical approach to the problem.

2. Ecosystems approach to health or EcoHealth

The idea of EcoHealth has been developed since the 1990s by the International Development Research Centre in Ottawa (IDRC), Canada [6]. It focuses on environmental and socioeconomic issues relating to human health with an action-research framework applied to socioeconomic development. Six principles of the EcoHealth approach have been described as a guideline for implementation. These include 1) *Systems thinking,* which can lead to a better understanding of health in terms of a social-ecological system by considering the relationship among the elements, such as the limits and nature of the problem, 2) *transdisciplinary research,* which involves the integration of research tools and methodologies across disciplines, including other knowledge and perspectives, 3) *participation* of all stakeholders, which builds up from the local root level and increases the impact of innovation at higher levels, 4) *sustainability* in social and ecological context, which is part of the change sought from EcoHealth research and action that can be motivated in this field (This change should be easily systematized, socially and culturally responsible and suitable), 5) *gender and social equity* that affects exposure to different health risks, health status and the goal of well-being (to reduce these inequities, all different social, economic, class, age, and gender factors should be considered), and 6) *knowledge to action* or knowledge translation, which is used to improve health and well-being through environment improvement [7].

Several success stories using the EcoHealth approach in disease control, particularly infectious diseases, have been documented, such as Chagas disease [8] and dengue [9]. The Lawa model also follows these EcoHealth principles while being tailored to our setting and existing local wisdom.

3. Opisthorchiasis control using EcoHealth approach: The Lawa model

3.1. What is the Lawa model?

The Lawa model is a new research-based strategy for integrative opisthorchiasis control using the EcoHealth/One Health approach [3]. It was first started in 2007 in communities around the Lawa Lake, Khon Kaen Province, an area endemic for opisthorchiasis in Northeast Thailand. The control program has been carried out for over 6 years using chemotherapy, novel intensive health education methods both in the communities and in schools, ecosystem monitoring and active community participation. As a result, the infection rate in the 13 villages surrounding the lake has declined to more than one half of the average of 60% as estimated by a baseline survey. People in the area gained more knowledge of the liver fluke. Strikingly, the cyprinid fish species, which are the intermediate host, now show less than 1% prevalence compared to a maximum of 70% during the baseline survey [3]. The Lawa model is dynamic. Several more research methods were introduced into the model such as social network analysis (Phimpraphai et al., manuscript in revision) and a targeted control program.

3.2. Systems thinking: EcoHealth and fluke transmission interruption

The fundamental solution of opisthorchiasis in Thailand requires multi-sectoral and multi-disciplinary involvement for effective and sustainable control [3]. The original idea of the Lawa model developed from a common sense approach taken by the research team, who understood the nature of the infection and its links with local culture, behaviors, beliefs, attitude, environment and practices. With lessons learned from inefficient control programs in the past three decades, our transdisciplinary team has identified six categories of obstacles to be overcome in crafting a new control strategy. These include: (1) culturally determined behaviors associated with fishing, food preparation, and eating uncooked fish, practices that are deeply embedded as part of the indigenous rice-fish culture of this region; (2) wetland ecosystem-dependent livelihood and an ancient co-evolutionary relationship of the *O. viverrini* and humans in this region; (3) a parasite highly efficient in its transmission though this coupled human-natural system; (4) a complex set of pathological consequences associated with infection and treatment community awareness; (5) historically unprecedented environmental change, including those caused by regional and local water resources management and flood control projects; and, (6) the most important, lack of continuity in government policy and control activities including geographic coverage [3].

Our systems thinking in integrated liver fluke control is to interrupt parasite transmission at every stage of the *O. viverrini* life cycle (Fig. 1). For example, the infected human has to be treated with praziquantel (PZQ) to eliminate the fluke and stop transmission of parasite eggs (from open defecation) to the environment or lake. Latrine installation is advised for households that do not have a toilet to minimize open defecation. Health education is essential for behavioral changes in eating raw fish and preventing re-infection. Waste treatment regulation and good sanitation practices should be in place to prevent parasite contamination in reservoir hosts. Several stakeholders have to be involved such as physicians, health officers, village health volunteers, teachers, the local governor, and even Buddhist monks. Many actions are possible. When the parasite eggs contaminate local water bodies, what do we do with intermediate hosts, *Bithynia* snails and cyprinid fish? Should we eliminate the snails by using molluscicides? Or minimize the number of snails by digging the lake shore deeper than 50 cm as the *Bithynia* snails prefer clear water not deeper than 30–45 cm [10,11]. These approaches may require the involvement of malacologists, ecologists, or even engineers. Should we require parasite inspection, or provide recipes for a safe cooked fish dish, for example? We may need fish biologists, food technologists, or restaurant owners to get involved. For reservoir hosts such as cats and dogs, we have to do stool examination and treatment to prevent parasite egg transmission. These actions will require veterinarians and even the local governor to make local regulations for controlling feral cats and stray dogs. All in all, for sustainable control in practice, we need government commitment to policy support. It is important to have political involvement as that is one of the key success factors from the famous theory, the "triangle that moves the mountain" developed by Dr. Prawase Wasi, a famous doctor who represents local wisdom from Thailand [12].

4. Development of control model

The Lawa model originated from community-based research on liver fluke-induced cancer in the endemic Chi River basin in Khon Kaen Province, Northeast Thailand in 2005. In 2006–2007, we did a stool survey in over 40 villages and found a more than 40% prevalence of *O. viverrini* infection. Particularly, the 13 villages close to Lawa Lake showed an average of 60% prevalence. This drove us to do more than basic research for our people. We designed a control program using the EcoHealth approach in combination with the knowledge of local individuals. The systematic process of developing the control model requires multiple steps, as follows.

4.1. Baseline data collection in all hosts

Prior to launching control measurements in the endemic area, baseline data on infection prevalence in all hosts throughout the life cycle of the liver fluke were collected. Stool examination was performed in humans (school children and adults), intermediate hosts (*Bithynia* snail and *Cyprinid* fish), and reservoir hosts (cats and dogs) (Fig. 2). We found *O. viverrini* infection rates of an average 9.2% in children from nine primary schools around the lake. Average infection in snail hosts was 0.18% while the fish from the lake showed a maximum 70% prevalence. Cats and dogs showed 34% and less than 1% infection prevalence, respectively. This baseline information is essential for delineation of a control strategy and evaluation.

4.2. Stakeholder engagement and participation

We organized several stakeholder meetings at different levels—village, sub-districts, districts, and province. Stakeholders are key informants, persons or local organizations recruited as crucial parties at each meeting. After these stakeholders were defined, we understood the current situation of opisthorchiasis infection in the target communities around the lake. A meeting between the parties was based on the principle of equality regardless of social or administrative rank, so that all delegates would have an equal chance to participate or voice their concerns and opinions (Fig. 3). All risk factors for liver fluke transmission and possible control measures were discussed, analyzed and synthesized for the best solution to benefit people in the Lawa Lake region. Details of each category are as follows.

- Define key actors: Key actors invited to the meeting were defined by their active and potential involvement in disease transmission and control. These actors included community leaders, the local governor, the health sector (physicians, village health volunteers, registered nurses, nurse aids, and public health officers), education sector (teachers, school principal, educational supervisors), veterinarians, and monks.

Fig. 2. Baseline survey for *O. viverrini* infection in humans (A), animal reservoirs (B) and intermediate hosts (D,E) are performed and samples are sent to the laboratory for investigation (B).

- Data presentation: Baseline information, being focused on the burden of *O. viverrini* infection in the community, was shared with the stakeholders. Other related information on local issues, beliefs, and culture was also brought into the discussion.
- Public hearing: Besides stakeholder meetings, public hearings in communities were also set up to gain an understanding and promote collaboration on the action plan of the model.
- Making decisions together: A friendly environment and the principle of equality in the meetings allowed all delegates to freely share information, concerns and opinions. Our staff were facilitators rather than leaders of the meetings. These processes were crucial for all parties to make decisions and establish a strong commitment and agreement on disease control and control over the health benefits.

4.3. Focus group interviews and discussion

To obtain information on the overall knowledge and practices of the local people in the Lawa Lake communities in detail, we conducted focus group interviews and discussions in every village. The information was used in designing the control model.

- *Questionnaire and interview*: Prior to conducting the questionnaire interviews, all informants had to sign the consent form to confirm that they understood and agreed with the conditions stated in the consent form. Our well-trained field technicians and village health volunteers conducted this process on-site.
- *Core of the interview*: Important information required from the interview included demographic data, any history of liver fluke infection and cholangiocarcinoma, and any risky eating habits. All questions were based on the knowledge, attitude and practice (KAP) of the informants.

4.4. Empowerment of village health volunteers

Village health volunteers are the key people who promote health activities at the village level. The village health volunteers underwent one-day training, which involved giving a lecture, practice talks and completing pre- and post-tests until they understood basic liver fluke transmission and prevention of infection. These volunteers have key responsibility for giving door-to-door health education to members of each household.

4.5. Empowerment of the local hospital staff

The Lawa model also empowers hospital staff in promoting health by teaching them to conduct stool examinations. We organized a two-day formal training session for hospital staff on parasite egg identification and differential diagnosis of liver fluke infection at Khon Kaen University (KKU). Additional hands-on training was done for a week at the Tropical Disease Research Laboratory, KKU. Hospital staff can do stool examinations for liver fluke infection in the Lawa communities.

4.6. School preparations

Schools and teachers around Lawa Lake are another key stakeholder and partners. As liver fluke infection relates to a “raw attitude” about food consumption among the Isaan [13] people who live in Northeast Thailand, health education for behavioral change communication (BCC) is needed for both children and adults. Since changes in habits in adults can be a bit difficult, new generations of school children are one of our target groups. Our transdisciplinary

Fig. 3. Stakeholder meeting and community engagement (A, B) on the basis of equality in the friendly atmosphere of a small group discussion (C) is important for making decisions and maintaining strong commitments in community participation.

team designed and developed several media on liver fluke disease control and prevention such as brochures, cartoon books, posters, and documentary videos. We also cooperate with the Khon Kaen Provincial Health Office, the Regional Center for Disease Control 7, and the Provincial Education Office, Khon Kaen, to develop a "*Curriculum of Liver Fluke and Cholangiocarcinoma*" for primary school children grade 4 to grade 6 in 2011 and a revised version in 2013. Schoolteachers who take responsibility for health subjects were trained on liver fluke and cancer and oriented on how to use the curriculum.

5. Integrated opisthorchiasis control in practice

As the Lawa model is a participatory community-based intervention, a local health promoting hospital (HPH) or primary care unit is the "*point of contact*" (POC). The Lawa HPH was the main node in the Lawa Lake community. The village health volunteers with Lawa HPH were key players in the control program. The five components of the Lawa model detailed below.

5.1. Anthelmintic treatment

All *O. viverrini* infected individuals and school children were treated with praziquantel (PZQ) (40 mg/kg body weight) as recommended by WHO [14]. To avoid the side effects of the drug, all subjects took the medicine after a meal. Reservoir hosts were also treated where possible to interrupt parasite transmission.

5.2. Community-based control activities

For community health education, five activities were performed.

1) Distribution of brochures about liver fluke infection and liver cancer to all households in the villages by organizing a parade of students from nine schools located around the lake.
2) Twilight health education. The Lawa model organized a kick-off campaign in every village around the lake to activate each community. Team leaders and local HPH staff gave a lecture on liver fluke infection and liver cancer within the village at night. Exhibition of liver fluke and liver cancer specimens, a poster, a light box, and a rollup poster were displayed. Several other activities, such as entertainment, dancing, asking questions, games, and more were included. The Lawa HPH director created "*edutainment*" media, such as 20 popular songs on liver fluke infection and CCA prevention and control as well as have choreographed each song based on a local Isaan dance. These songs are an easy and effective way to access the perception of the local people. All village leaders, local health personnel, village health volunteers and villagers were invited to join the event.
3) Door-to-door health education. After the big event described in section 2, well-trained village health volunteers taught health education to their responsible household members (one volunteer taking care of about 10–15 households). The research team provided a large education poster and a leaflet on liver fluke infection as media resources. The door-to-door health education activity operated twice a year. This activity ensured that all household members are educated on liver fluke disease and on how to prevent the infection.
4) Public service. We prepared a folk song on CD about liver fluke infection and liver cancer to be broadcast every day in targeted villages.
5) Big billboard posters of the liver fluke campaign were displayed in all villages.

Representative community-based control activities are shown in Fig. 4.

Fig. 4. Information, education and communication (IEC) or Behavioral change communication (BCC) in the Lawa model campaign. Our research team lead by Dr. Banchob Sripa gives a twilight education on the background of liver fluke infection and CCA (A). Community activation by our village health volunteers (B). Empowering village health by intensive on-day training (C) and they will translate the knowledge in a simple way to villagers by door-to-door education (D) and edutainment (E).

Fig. 5. The "liver fluke-free school" program. The school-based control operated in nine primary schools around the Lawa Lake. After three years of implementation, all schools were free of *O. viverrini* and other parasite infection and receive a certificate of "liver fluke-free school" to put in front of the school (A). School health education include exhibition of real parasite and cancer, brochures, poster, video, and games (B). Formal health education using a curriculum of "Liver fluke and cholangiocarcinoma' and several media including video, cartoon, etc. (C,D,E) was conducted in all schools.

Fig. 6. Policy makers and Lawa model. Director General of Department of Disease Control, Ministry of Public Health, Thailand and team visited Lawa model (A,C). Liver fluke and cholangiocarcinoma kick-off ceremony in Sakolnakhon Province, January 2016 (B).

5.3. School-based control activities

For school health education, activities similar to those in the community were performed but were more intensive. We gave a pre- and post-test on knowledge of liver fluke and liver cancer. We displayed a big exhibition with microscope, liver cancer specimens, fishes, worms, and more along with several games about the liver fluke as well as a drawing of the liver fluke life cycle. The headmaster of the school and all teachers joined the health education activities as did the local health personnel and volunteers.

Apart from the lecture and exhibition on liver fluke and liver cancer, the Lawa model also established a more sustainable program called the "Liver fluke-free school" in eight schools around the lake. The curriculum developed within several sectors described in 4.6 was implemented in school children grade 4 to grade 6. This curriculum consists of 10-hour lecture activities per year for each class. After 3 years of implementation, all school children were free of liver fluke and other parasites. We then gave them a certificate declaring a "Liver Fluke Free School" with a big billboard to put in front of the school. This billboard aimed to make school children and people in the village aware of liver fluke infection and cholangiocarcinoma. Representative activities are shown in Fig. 5.

5.4. Monitoring & evaluation

As mentioned earlier, the Lawa model activities are dynamic, as it involves intensive participatory action. We monitor and evaluate every key activity from time to time for improvement of the model. Summative and formative assessments were used as appropriate. We have baseline data on *O. viverrini* infection in all hosts, demographic data, behavior, attitude, and more from questionnaire-based interviews and community participatory epidemiology. For community-based control, key indicators were reduction of infection rates and improvement of knowledge, attitude and practices (KAP) toward the eating raw fish (behavioral change). For school-based control, we had formal pre- and post-tests for the KAP and the reduction in liver fluke infection as key indicators. For the environment, we studied liver fluke infection rates in the snails and fish, water quality and monitored fecal bacterial contamination to understand liver fluke infection ecology. Reduction of the parasite infection rates in the intermediate hosts are also key indicators for environment monitoring. Altogether this formed the basis for eco-bio-social interaction against this persistent infection in the region.

The main achievements of the Lawa model over the past ten years are summarized here. As described elsewhere [3], the liver fluke infection rate in the population went down to less than 10% in all villages from the baseline of 60% average prevalence. There was no liver fluke infection in all school children after 3 years of implementation. All humans gained better KAP, indicating behavioral changes after implementation. For the environment, no infected *Bithynia* snails were detected in the lake compared to 0.18% prevalence at the baseline. The *Cyprinid* fish in the lake now showed less than 1% infection prevalence from the maximum 70% at baseline. Fecal contamination and snail abundance due to high salinity and nitrate-nitrite were key factors involved in liver fluke transmission in a high endemic village [15]. We now understand clearly the human-liver fluke-environment interaction in the Lawa Lake region.

5.5. Sustainability development

The Lawa model has been established in the lake region for over a decade. Our team was aware of its suitability and sustainability so we designed an intensive community participatory approach. We used a local HPH as a POC. All stakeholders including the local governor, village

leaders, school headmasters, village health volunteers, and others in the community have been invited to participate actively since the beginning of the project. All implementation activities were based on our consensus agreement. They feel that they own the model and are proud of it. We empowered every key player in the field including village health volunteers, HPH staff, and schoolteachers (Section 4). During early development of the model, our TDRC team at Khon Kaen University had to do the stool collection and examination. All campaign activities were led by our investigation team using our grant budget. Nowadays, the Lawa HPH conducts the control campaign and stool examination every year by themselves using a budget from the local governor. The greater cooperation among local stakeholders results in their working more closely together. The local governor understands the control activities, as he is one of the partners, so most implementation budgets are from the local governor's office. We as investigators now act as supervisory and support role that is mainly academic and involves cooperation with higher-level policy makers.

6. From the research bench to the national agenda

The implementation of the Lawa model required policy makers at different levels to get permissions, facilitate activities, support infrastructures, and work to place the issue on the national agenda. The plan originated with researchers from Khon Kaen University, Higher Education Office, but required multi-sectoral stakeholders in Khon Kaen Province to succeed. We contacted several chiefs of provincial/district offices such as the Khon Kaen governor, offices of health, education, fishery, the environment, and the Regional Department of Disease Control 7. At the community level, we had to contact subdistrict chiefs (*kamnan*) and village chiefs (*phu yai ban)* and the local governor or Chief of the Subdistrict Administrative Organization (SAO). These people were invited to share information and opinions in all key meetings. For the local governor, this meant not only their suggestions, but also discussion of budgets for routine stool examination and campaign activities. Their cooperation is one of the key reasons for the success of the Lawa model.

At the national level, several groups at Khon Kaen University tried to convince high-ranking health officials and local politicians to place liver fluke infection and cholangiocarcinoma on the national agenda. However, for ten years the disease was not considered a priority by the Ministry of Public Health (MoPH). Moreover, the political crisis in Thailand obstructed attempts from time to time to make the disease a higher priority. Our Lawa model was first introduced to the MoPH by the Secretary Permanent in 2009, but there was no immediate progress. During the time, we demonstrated with evidence-based studies that although the liver fluke infection rates in Northeast Thailand remained high, the program - the Lawa model - was successful, and rates were falling. This attracted the attention of the MoPH again. Several groups of health personnel in endemic provinces visited Lawa Lake and were trained in the integrated liver fluke control program. In 2015, the Director General of the Department of Disease Control (now the Secretary Permanent of the MoPH) and his executive administrators also visited and learned about our Lawa model (Fig. 6). As a team with other sectors including Liver Fluke and Cholangiocarcinoma Research Center, Cholangiocarcinoma Screening and Care Program (CASCAP), and MoPH, "Elimination of liver fluke (opisthorchiasis) and bile duct cancer (cholangiocarcinoma) in people" was successfully placed as an item on the national agenda at the 8th National Health Assembly (December 2015). The EcoHealth approach for liver fluke infection control used in the Lawa model was included on the agenda. The official kick-off national campaign against liver fluke infection and cholangiocarcinoma in 84 endemic districts was in January 2016. This new campaign aims to eliminate the disease within 10 years. The idea of the Lawa model is now being scaled up to work in larger areas in Thailand. Internationally, the "Lawa model" is one of two programs that are showcased as successful control programs for helminths by WHO Neglected Zoonotic Diseases [5] and the program is being recognized by neighboring Mekong countries where the liver fluke is endemic.

7. Conclusion: Behind the scenes of a success story

The Lawa model has gained recognition nationally and internationally as a successful parasitic control program using an integrated, community participatory EcoHealth/One Health approach. By using systems thinking on the nature of problems in its design, the model is lively, dynamic, flexible and adaptable, depending on the local setting. Therefore, it can be scaled up and adopted to other endemic areas. The principles can also be applied to other disease control issues. In addition, transdisciplinary, multi-stakeholder and intersectoral involvements are essential for this EcoHealth/One Health approach.

Practically, of the lessons learned from the Lawa model, the importance of community participation is one. The key to the success of the project is multi-stakeholder participation with active local HPH and the village health volunteers. Looking back on our Lawa model, we have completed the disease control loop using EcoHealth and local wisdom. The main strength of the Lawa model is research-based intervention. All activities were coupled with basic and applied research including concrete data support. Over ten MSc/PhD/Post-doctoral researchers worked in the Lawa Lake community. In conclusion, the development process of the Lawa model starts from knowledge development, stakeholder participation, systematization, and all lead to the appropriate intervention as the principles of EcoHealth [7] and "*triangle that moves the mountain*" [12]. Our experience is an example of translational research that applies academic knowledge and research output to solve a local problem, as reflected in our TDRC motto "*From bench to community*".

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