



Water Use by Inland Aquaculture in Thailand: Stakeholder Perceptions, Scientific Evidence, and Public Policy

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Abstract

This paper assesses the significance of stakeholder discourses on uses of water by aquaculture for public policy. Our discourse analysis focuses on the experiences with inland aquaculture in Thailand, drawing from interviews with stakeholders, and evidence in public documents such as newspapers and television news reports. A key finding is that fish farms suffer significant losses from polluted run-off entering water bodies where fish are grown. Mass mortality events in river cage culture, in particular, attract media attention and are the core of the *aquaculture-as-victim* discourse. Fish farms are also adversely impacted by river management and current water allocation policies. Inland shrimp farming has received more negative media and scientific attention than fish farming, and is the focus of the *aquaculture-as-villain* discourse. A third, *aquaculture-as-benign* discourse, is used widely to describe fish pond culture, and more rarely to promote aquaculture in low-quality water bodies or as part of integrated nutrient and waste re-use farming systems. The findings strongly imply that aquaculture farmers should be included as a stakeholder in the management of watersheds and rivers, as well as the negotiation and allocation of water resources. They also suggest a need for aquaculture development policies to pay closer attention to water quality and allocation issues.

Keywords Aquaculture · Mass mortality · Water pollution · Water use · Discourse

Introduction

The merits and limitations of aquaculture development are often widely debated. Typically, a highly critical discourse of “environmental damage” or “industry corruption” is pitted against supportive “best management” or “alternative livelihood” discourses. The influence of these debates on aquaculture development and governance seems to have varied greatly among countries and over time.

Looking at shrimp farming, which has taken place primarily in developing countries, Bene (2005) contrasted a political ecology discourse of an industry producing few benefits for the rural poor with the best management

discourse that acknowledges past problems and promises to address them with better techniques. In the case of Thailand, the best management discourse for shrimp has helped to de-politicize industry development through the standardization of practices and an emphasis on technical expertise (Lebel et al. 2008). In the salmon industry in Chile, discourses of best practices were similarly used by growers and their supporters to defer direct regulation (Barton and Fløysand 2010).

A study of how Norwegian newspapers have covered debates around salmon aquaculture identified two opposing alliances with distinct discourses and character roles (Osmundsen and Olsen 2017). The first includes journalists, sports fishers and private individuals, and is highly critical of the sector, making claims about environmental impacts and corruption. The second includes more government, industry and some large environmental NGOs, and sees aquaculture favorably but with environmental challenges that need to be addressed if the sector is to become more sustainable. The two framings in the Norwegian media debates appear to be in a deadlock with positions and discourses not evolving over time.

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Debate over aquaculture development in Canada has also been polarized (Pigeon and Létourneau 2014). Environmental NGOs have led the opposition to industrial aquaculture with a discourse built around concerns over environmental health, local communities and “respect for wilderness”. Experts in this debate support public participation as a way to strengthen expert claims, but are highly critical when the public reinterprets their claims (Young and Matthews 2007).

Public perceptions of risks and concerns with planning and management have constrained the development of aquaculture sector in Australia, where conservation groups, informed public, ecotourism industries, local governments and some state agencies tend to focus on negative risks from aquaculture (Mazur and Curtis 2006); they seek planning and management that would reduce those risks, but if these are perceived as high, then there is also a tendency not to trust government or aquaculture industry management activities. In many parts of the world where aquaculture production is limited, the poor image of the sector has been created by media reports focused on pollution and mangrove destruction, while contributions to poverty alleviation and economic development go un-reported (Chuenpagdee et al. 2008).

Water use is an important underlining component of these aquaculture debates. In the environmental damage discourse, the salmon industry in Norway exploits and degrades “pristine waters” (Osmundsen and Olsen 2017). In Chile, good water quality in freshwater locations for hatcheries and nurseries were important in justifying the establishment of industry (Barton and Fløysand 2010). The claims made about the impacts of aquaculture on the quality of water available for other users and ecosystems have influenced public policies on aquaculture development, for instance, in the form of stricter regulations (Abate et al. 2016). Evidence of the converse is less clear; one possible example comes from New Zealand, where there is pressure to improve management of dairy production in coastal watersheds, because of the threat run-off poses to “clean and green” salmon aquaculture (McGinnis and Collins 2013).

These examples show that there is a lot of variation in how aquaculture has developed in different countries, and that competing discourses are often present. Past studies also hint at a range of discursive strategies through which actors promote their concerns around water uses. It is unclear however, to what extent the content or dynamics of competing discourses can help explain the evolution or diverse outcome of associated public policies on aquaculture and water use (Lebel et al. 2018).

To address this problem, in this paper we first distinguish three aquaculture discourses (villain, victim, benign) around water uses by aquaculture in Thailand, noting who

articulates them and where. We then attempt to trace the consequences and implications for politics and policy. The aquaculture sector in Thailand is particularly suitable for an investigation of aquaculture discourses, since it has a well-developed aquaculture sector with many small-scale farms, as well as large private companies (Belton and Little 2011), and water resources are under pressure from multiple uses (Panuwet et al. 2012; Schwantes et al. 2009). The aim of this paper is to draw out the implications of these stakeholder discourses on water uses by aquaculture for water resources management and aquaculture development policies.

Methods

This study used discourse analysis to categorize dominant lines of spoken or written reasoning, and the situations in which they were used (Hajer and Versteeg 2005). To make the analysis more tractable we paid special attention to exchanges around claims of impact; either of aquaculture on water conditions or of activities of other users on aquaculture.

We drew on a combination of interviews, surveys, public documents and media reports over a period of just over 2 decades (1995–2017). Drawing on observations from this period allowed consideration of infrequent mass mortality events and climate extremes. The period was also sufficient to explore how public discourses and policies have evolved and been influenced by discourses.

Interviews

This study drew on in-depth interviews collected primarily for other purposes, but including information about water quality issues, pollution events, and river or watershed management by the authors between 2005 and 2017. Set A was made up of 82 interviews done in July 2005–June 2007 with fish farmers and other stakeholders in the Upper Ping River Basin in Northern Thailand (see Lebel et al. (2013)). Set B included 68 in-depth interviews conducted in 2013 at various locations in Northern Thailand with river-based fish cage farmers and other stakeholders (Lebel et al. 2015a). Set C included 5 in-depth interviews with government officials conducted in June–August 2017 to update information on the implementation of new Fisheries and Navigation Acts. Key government officials interviewed included representatives from the departments of Fisheries, Irrigation, Water Resources, as well as local governments. All interviews were conducted in Thai, fully transcribed and coded in Thai, and only translated into English in drafting the written manuscript.

Surveys

Apart from in-depth interview sources we also analyzed three quantitative surveys for additional information. Set D was a quantitative survey of 662 river cage fish farmers carried out in October 2012–March 2013, which provided information about the prevalence of different perceptions of risks from pollution and water management operations (Lebel et al. 2015b). Set E was from a quantitative survey of 97 reservoir cage fish farmers between March–April 2015 (Lebel et al. 2016). Set F was from a quantitative survey of 585 pond fish farmers in April–July 2013 (Pimolrat et al. 2013).

Media Reports and Public Documents

Media items and public documents about water quality issues, pollution incidents, and river or watershed management disputes involving pond or cage aquaculture in inland (non-coastal) settings were searched using Google, YouTube, and online archives of English and Thai language newspapers from Thailand. Search terms were chosen to cover fish and shrimp culture water use issues in Thailand, and included aquaculture, mass mortality, water pollution, fish kills, dam operations, water conflict, shrimp farm, and fish farm.

A total of 398 candidate items, of which 75 were video clips, were collected. In terms of language, 71% were in Thai and 29% in English. Text summaries posted along with clips were used, if available, and supplemented with brief notes as needed for coding. The majority of items (72%) were newspaper articles or online TV channel news reports; rarer were journal articles and agency reports. The original publication dates of items ranged from 1995 through to 2016. News items from archives of two English language dailies were used to study trends over time, as they were a relatively complete subset compared to other sources. In extracting impact claims for further analysis, emphasis was placed on direct quotes and paraphrased statements of aquaculture stakeholders, including fish or shrimp farmers, government officials and affected individuals interviewed by reporters.

Analysis

The analysis of documents, summaries, and interview transcripts was done using NVIVO software as follows.

First, statements were coded as being about either the risks to aquaculture from other water users, or the impacts of aquaculture water use. Second, sources of impacts were recognized, including industry, shrimp ponds, and dams. Third, the identity of the person making the claims was classified into broad stakeholder categories. Fourth, statements and surrounding text were scanned for references to accepting or rejecting the authority of a stakeholder as evidence of perceived legitimacy.

Results

Three discourses around aquaculture water use were identified (Table 1) based on grouping information on claims about impacts and their sources.

Aquaculture-as-victim

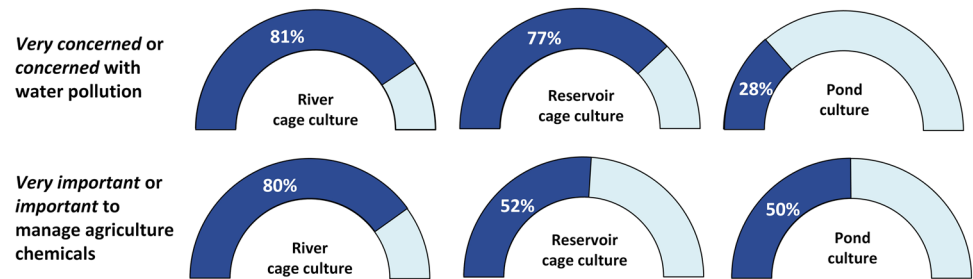
The *aquaculture-as-victim* discourse is most prominent in media coverage of mass fish mortality events in rivers (Table 1). In 2013, mass fish mortality events in the Ping River, downstream from Chiang Mai City and Lamphun industrial estate, killed 100,000 fish worth 4 million baht (ThaiPBS 2013a). Farmers attributed the losses to polluted water from the Mae Kha Canal that drains storm water and domestic wastewater from urban Chiang Mai (ThaiPBS 2013a). Not surprisingly, surveys show that wastewater from industry and human settlements are a major source of worry for cage aquaculture in rivers and reservoirs of Northern Thailand (Fig. 1). In the central region, pollution in Saraburi flowing into Ayutthaya in 2015 caused 500 million baht in losses (RYT9 2015). The provincial governor later acknowledged to protesting fish farmers that the mass mortality of fish in cages in the Pasak River was caused by ethanol factories illegally discharging wastewater (ThaiPBS 2013b). A promise was made to enforce penalties until the factory met effluent standards.

Wastewater from sugar mills has been blamed for several mass mortality incidents in the Chao Phraya River. In 2007, experts initially attributed a mass mortality event in the Chao Phraya River near Anghong to the capsizing of a boat carrying refined sugar which resulted in high BOD; other experts argued that the amount of sugar was insufficient to

Table 1 Concise summary of key features of three aquaculture water use discourses in Thailand

Discourse	Culture system most frequently targeted	Water use related impacts given most attention	Stakeholders typically articulating discourse
Aquaculture-as-victim	River cage culture	Mass fish mortality from industry pollution of waterways	Mass media, fish farmers
Aquaculture-as-villain	Pond shrimp culture	Salinization of rice paddies	Environmental NGOs, rice interests
Aquaculture-as-benign	Pond fish culture	Rarely mentioned	Fisheries Officials, livelihood NGOs

Fig. 1 Fish farmer perceptions of the risk from water pollution to the profitability of their fish farms, and the importance given to managing agriculture chemical run-off. Percentage of fish farmers in rivers ($n = 662$), reservoirs ($n = 97$), and ponds ($n = 585$)



have the huge impacts observed (The Nation 2007b). Fish farmers blamed a local factory producing monosodium glutamate (MSG) (The Nation 2007a). To encourage government action against polluting firms, farmers did more than merely voicing their concerns; they also dumped nearly a ton of smelly dying fish at the entrance of one of the factories (Khaosod 2007), and dug up discharge pipes allegedly used by factories to illegally release wastewater into the river (The Nation 2007a). In the aftermath, the Pollution Control Department (PCD) inspected four factories to obtain samples of wastewater to determine the causes of fish death. Meanwhile, the Director-General of the Department of Fisheries said “the dead fish were neither toxic nor was the water in the Chao Phraya River; fish died because of lack of oxygen” (Khaosod 2007). The Agriculture Ministry initially offered generous compensation for each cage of fish lost, but then reduced it to a much lower standard amount of emergency relief, arguing that the polluting firm should be the one to compensate, and this should only be pursued after PCD completes its report (The Nation 2007a).

This retreat from initial hardline statements on industry practices to a need for more samples and studies is a common discursive tactic following suspected pollution events, and consequently reinforces the perception in many communities that:

... the authorities tend to be biased in favor of industrialists at the expense of farming communities. (The Nation 2007a)

Moreover, court cases against polluters are rare. Under Thai civil law, the burden of proof lies with the person making the complaint, which can be difficult given the often multiple potential sources. One exception was a case in Bangkok in 2009, where the owner of a fish farm and restaurant successfully sued a manufacturer of vehicle spare parts for discharging untreated wastewater into a public waterway and killing all their fish (Bangkok Post 2014).

In 2016, in Northeastern Thailand, polluted wastewater discharged by a factory into the Pong River killed 15 tons of fish in river cages (TNN24 2016), leaving fish farmers “in tears” (NBT KhonKaen 2016). In Kalasin province,

polluted water from sugar and cassava factories in November 2016, for instance, was suspected by fish farmers to be the cause of a mass mortality event that resulted in 17 tons of dead fish (Thai Rath 2016a). However, officials found nothing unusual in the water samples collected after the event, and thus suggested that farmers collect water samples during subsequent events. Officials also recommended reducing stocking densities. Shifting responsibility or blame back on fish farmers is a common discursive tactic of government authorities, reducing their legitimacy among farmers.

In the Upper Ping River in 2006, effluents from pig farms was an issue as it killed fish, but farmers could not get the attention of officials and dared not speak out against the well-connected owners (Lebel et al. 2013). In the Central Plains region, pollution from pig farms in Ratchaburi province released into public waterway was blamed for harming freshwater fish and shrimp in two provinces downstream (Bangkok Post 2017). Aquaculturalists rallied at the provincial hall demanding authorities take action.

In surveys across Northern Thailand, many fish farmers with cages in rivers, and to a lesser extent, cages in reservoirs or earthen ponds, believe it is important to properly manage use and run-off of pesticides from orchards and crop fields (Fig. 1). Chemicals used in agriculture flowing into waterways can have acute effects, killing all fish quickly [B57], leaving fish farmers no time to do anything to reduce losses [B33]. Officials from the Department of Fisheries believe it is impossible to stop rice farmers from using the pesticides that impact fish farms [B04], and thus:

... it is getting more difficult to rear fish because water quality is declining from fertilizers and chemicals used in agriculture that wash into rivers when it rains...in public water bodies, it is impossible to manage the chemical inputs, but in ponds on private land they can be controlled. [B06]

In practice, as fish ponds often obtain water from streams or canals, they are also susceptible to upstream activities. In the Lake Phayao region, farmers interviewed told us about losses in pond culture systems following spraying of pesticides in surrounding rice fields. Some rice farmers counter

by saying that it is the fish farmers themselves who are poisoning their aquaculture with too much medicines and vaccines (Janchitfah 2011). Growers of the giant river prawn (*Macrobrachium rosenbergii*) identify agriculture as the most important source of external pollution affecting their farm operations (Schwantes et al. 2009).

The operations of large dams to generate electricity, irrigate fields and reduce flood risks have significant impacts on fish farms. As floating systems, river cage culture is well-suited to modest changes in water depths and flow velocities, but extreme changes in these parameters arising from river regulation can have devastating impacts. In Northern Thailand, 88% of surveyed fish cage farmers rated water releases and storage by dams as “very important” to managing risks to the profitability of their farms (Lebel et al. 2015c).

In 2016, fish cage farmers in Ayutthaya lost more than 1 million fish following water releases from Chainat Irrigation Dam (TVChannel 8 2016). During high flow periods, the actions of the Irrigation Department are under close scrutiny. Diversions using irrigation infrastructure to protect fields or settlements in one area can severely impact other areas, including those with fish ponds, a problem compounded when dams break, as occurred in Singburi and Ayutthaya in 2006 (The Nation 2006).

Dam releases have also been reported to have trans-boundary impacts (TVChannel 7 2016). Water released from dams may be of low quality even without external sources of pollution upstream, and this can also cause mass mortality events as reported for cages in the Nan River in Phitsanulok province (Phitsanulokhotnews 2013). Opening of flood gates in the Pak Phanang River, allowing large volumes of freshwater into the brackish conditions downstream, changes water quality conditions too rapidly for fish to adjust, killing both wild fish and sea-bass reared in cages (ASTV Manager 2014).

Very low flows when dams upstream hold back water for future storage, or when they divert flows from main channels to irrigation schemes, can also have large impacts. Disrupting flows into the Pattani River had serious impacts on tilapia farms in 2012 (Sanook 2012), and again in 2016 (Thai Rath 2016b). In 2015, in a village in Surin where fish farming is a major livelihood, farmers organized a meeting with reporters because “they had written several times to the Irrigation Department but got no response” (GooSiam 2015).

In the Upper Ping River, small weirs used to divert water for irrigation create important deep-water refuges in the dry season for river cage culture. These weirs are so useful that fish farmers helped lobby for the repair of a key weir damaged by floods in 2005–2006. As fish pond farmers may draw water from irrigation canals, they can be impacted by the release and allocation priorities of the

Irrigation Department. In Payao province, fish ponds on private land are located within an area served by a community-managed irrigation system (Kengkaj 2015). The local policy was that areas near the main canal in the irrigation area was zoned for rice, and when several fish farmers joined together and made a written request to the local irrigation leader, or “Kae Muang”, for an allocation of water during a period with low flows, their request was rejected. When they complained to the local government they were told that they had to reach an agreement with the irrigation leader.

In summary, the *aquaculture-as-victim* discourse was primarily targeted at river cage culture. The source of pollution is usually identified as “industry” in mass media, though in interviews fish farmers are convinced that urban and agricultural run-off is also important. Operation of dams to meet irrigation or flood management objectives also have impacts on aquaculture. The *aquaculture-as-victim* discourse has perhaps grown in latter periods (Fig. 2), but has had limited influence on government policy on water management or pollution control beyond the short-term reactions to mass mortality events. The key policy implication from this state of affairs is that aquaculture should be a recognized water user in stakeholder consultations and negotiations.

Aquaculture-as-villain

The *aquaculture-as-villain* discourse draws attention to water use and wastewater discharge of aquaculture activities. Inland farming of the Pacific white shrimp, in particular, has been a controversial issue in Thailand, as it requires the importation of saline water for use in early stages of culture (Flaherty et al. 2000). In the dispute over

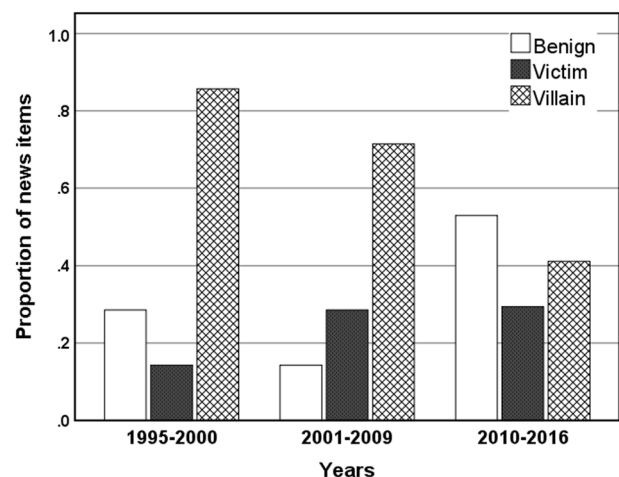


Fig. 2 Prevalence of three aquaculture water use discourses in three time periods. Proportion of news items in English daily newspapers from Thailand referring to at least one discourse ($n = 45$)

inland shrimp farming, those opposed to aquaculture argued the importance of preserving the central region as the “rice bowl” of Thailand. Yadfon, an environmental NGO, argued that:

We should not let the country’s best rice land become threatened by salinization. Its impact could be immense, as no one can speculate how much effect the leaked salt water will have on nearby rice farms and canals. (The Nation 1998)

Earlier, the head of the PCD announced that “shrimp farms and other aquaculture will be listed as a source of pollution in line with the 1992 Environment Act” and called for management plans (Bangkok Post 1995). In 1998, PCD officials convened a study which concluded that:

Inland prawn farming is potentially damaging to the ecological system and should be banned until it can be proven that it poses no threat to the environment. (Bangkok Post 1998b)

Shrimp farming communities strongly opposed the ban and questioned the credibility of the science it was based on (Bangkok Post 1998b). Farmers decided to ignore the ban, and were supported in part by officials from the DOF, who emphasized the commercial importance of the sector in their arguments and disagreed with the board’s proposed ban (Bangkok Post 1998a).

The directive in 1998 that banned “inland” shrimp aquaculture was worded in a way that left some flexibility in implementation for provincial governors. Later, further changes in the definition of the salinity threshold meant that some inland areas might then be considered suitable for low salinity white shrimp culture, since they would be reclassified as “non-freshwater” zones (Bangkok Post 2011).

A combination of seepage, pond discharges, and sediment flushing meant that much of the salt introduced to shrimp ponds enters adjacent canals and rice paddies (Braaten and Flaherty 2001). Total water use per hectare per crop was estimated at only 10% of total agricultural water use in the Bang Pakong Basin (Szuster and Flaherty 2002). Apart from salinization, there are some other potential deleterious effects from shrimp pond effluents on the water quality of receiving environments. Measurements made near shrimp farms in freshwater parts of the Songkhla Lake Basin, suggest that discharge of pond effluents also increases BOD and high total suspended solids in nearby water bodies (Tanavud et al. 2001). A spatially explicit material flow analysis identified aquaculture as the largest source of nitrogen and phosphorus inputs to the Bang Pakong Basin (Kupkanchanakul et al. 2015), where there is

substantial fish but also crocodile, shrimp and artemia culture (Soontornprasit and Meksumpun 2008).

The need for better policy coordination for the aquaculture sector with other water users is well illustrated by the controversy caused by the introduction (in early 2017) of the new Thai Navigation Act (No. 17) by the Marine Department (formerly Navigation and Harbors) of the Ministry of Transport [C405]. Under the new legislation, fish farmers had 120 days to register their river-based farms and pay both fines for previous use and “compensation fees” based on fish cage areas. Those who failed to do so would face even larger fines and even imprisonment. Fish farming groups around the country, sometimes with support from provincial National Farmers Federation branches, wrote protest letters to various government agencies calling for delays in implementation, removal of past fines and reduced fee rates for fish-farm uses of river space [C403]. In early July 2017, the Director-General of the Marine Department announced a revision of Act 17 so as not to impact inland fish farms; but observers expect more twists and turns in the future.

In summary, the *aquaculture-as-villain* discourse was primarily targeted at inland shrimp ponds because of their impacts on salinization; river cage culture has also been criticized from time-to-time for its nutrient contributions. The *aquaculture-as-villain* discourse has had substantial influence on policy, triggering regulations and zonation, but these initiatives have been contested by aquaculture interests resulting in a complex set of compromises and other outcomes. Peak interest in this discourse with respect to shrimp culture was about 2 decades ago and seems to be declining (Fig. 2). The key policy implication from this discourse is that aquaculture water uses need to be regulated—for instance through standards or zoning.

Aquaculture-as-benign

Most stakeholders we interviewed believe that fish farming in ponds on private land is invariably a benign activity; and in rivers, at current levels, a relatively benign activity. In this discourse, accumulated waste inputs are quickly diluted and dispersed with uneaten feed eaten by wild fish. In Northern Thailand, the impacts from fish farming on water quality are often argued to be lower than some other human activities [A66], noting that “if they rear pigs, it smells, and disturbs others for 2–3 km around” [A91]. Contributing to the local community helps secure the social license to operate. Having fish farms nearby meant one “gets to eat fish cheap and do not have to travel to get it” [A92]. The right to a livelihood is also emphasized by other farmers with orchards or rice paddies:

Fish farming does not have impacts. Fish farms float in the river. They do not block the water; water can flow past. In my view there are no impacts. It is their livelihood. If they did not farm fish, they would not be able to make money. [A84]

At current levels of production, adverse impacts on water quality are most visible during low flow periods in the dry season [A54], but as one official told us, there is self-organizing correction at work as “the impacts are felt directly by fish farmers: their fish die” [A53]. Looking to the future, however, several informants in different categories of stakeholders expressed concern that expansion and intensification could create water quality problems [A53, A71]. Experts note the potential for fish culture to be integrated with production of livestock (Pant et al. 2004), high-value hydroponic vegetables (Kardsakun et al. 2014), or as part of wastewater re-use systems (Bunting and Edwards 2018), potentially shifting the *benign* discourse even further to one of *aquaculture-as-hero*.

In summary, the *aquaculture-as-benign* discourse is used predominantly to describe fish pond culture on private land. This discourse ignores the inter-connectivity often present with other water users, for instance, in local irrigation schemes. The *aquaculture-as-benign* discourse has been ignored by water management policy as it justifies the existing low priority of aquaculture as a water user, but has attracted modest attention from aquaculture development programs to support alternative, low external input or organic pond culture. The discourse has grown more prominent over time (Fig. 2). The main policy implication of this discourse is that it is often reasonable to ignore aquaculture water uses, while in some locations and years, it would be beneficial to include aquaculture stakeholders in water management bodies.

Discussion and Conclusion

Claims about risks to aquaculture water use from other activities have been widely reported in popular media, as a consequence of costly and visually disturbing mass mortality events in cage culture in rivers. Evidence from interviews confirm media reports that fish farms face significant risks of losses from polluted run-off and effluent entering waterways or bodies where fish are grown. The sources of pollution causing mass mortality events in rivers or reservoirs is often suspected but difficult to prove, and rarely leads to fines or compensation. Typically, ad hoc sampling is done after a mass mortality event. The findings are rarely published in full, and consequently, the findings are often inconclusive. Fish farms are also adversely impacted by river management, including both sudden

releases of large volumes of water and storage, or diversion operations that drastically reduce river flows. The impacts of flow modification on aquaculture farms is reported in mass media, especially when it results in mass mortality events and large commercial losses. Despite this, engagement of fish farmers in water resources management is very limited, and much less than established users like rice paddy farmers. Experts have been relatively silent on these issues, and there has been no significant public policy change. The discourse of *aquaculture-as-victim* has grown more prominent, but so far has not been influential in policy development related to water use.

Claims about the impacts of aquaculture water use on water quality and the environment have received relatively more attention from academics and experts in the bureaucracy. Claims about adverse impacts of shrimp production on water resources far exceed those about fin-fish, and are similar to *aquaculture-as-villain* discourses identified in other countries (Bene 2005; Osmundsen and Olsen 2017; Pigeon and Létourneau 2014). In the case of shrimp pond impacts on salinization, this attention was mirrored in the mass media and led to a controversial ban (Flaherty et al. 2000). Two opposing coalitions quickly formed and were maintained for several years. Policy was influenced by advocacy from both sides, flip-flopping between bans and lifting of bans, and re-definition of freshwater zones. As in other parts of the world, the *aquaculture-as-villain* discourse has provoked regulatory responses (Lebel et al. 2018); but in Thailand these have been resisted, and thus incompletely implemented.

An unusual feature of this study from Thailand, for scholarship on aquaculture discourses, is that the discourses supporting and opposing aquaculture water uses have largely run in parallel, rather than in direct contest with each other. This situation arose because different culture systems, despite being all inland, had distinct water use issues. This has made, for example, “generalized critiques” of aquaculture by environmental NGOs hard to sustain. Another significant feature is the alignment of private companies with fish farming interests that work in parallel with conventional agriculture extension work by the state (Belton and Little 2011). This lends a certain fluidity to “livelihood security” versus “commercial benefit” justifications for aquaculture water uses.

There are several important implications for public policy on aquaculture water uses in Thailand—and potentially for other countries in the Mekong Region with established or rapidly growing aquaculture sectors—that emerge from this analysis of stakeholder perceptions and discourses.

First, aquaculture should be treated as another water use, and thus fish and shrimp farmers as water users, in negotiations over the management of watersheds and rivers (Lebel et al. 2018). From the perspective of fish farmers,

both water quality and volume allocation issues are important. Fish cage farms in rivers are dependent on good water quality, and thus have significant, but under-recognized shared interest with those supporting healthy rivers and the conservation of aquatic ecosystems. Fish cage and pond farms in irrigation areas also have strong interests in the allocation of dry season water flows, and the diversion and storage of wet season flows, as these can greatly impact water depths and volumes available for use by aquaculture. Fish and shrimp farmers need to be part of the planning and management of local water supplies (Schwantes et al. 2009).

Second, having recognized the aquaculture stake in water management, existing laws and regulations to control pollution of waterways need to be much better implemented. The overall legal framework is provided by the 1992 “*Enhancement and Conservation of National Environmental Quality Act B.E. 2535*”. But greater effort is needed to control discharges of inadequately treated domestic and industrial wastewater (Boontanon et al. 2013; Simachaya 2009), as well as addressing the management of non-point sources of pollution, in particular, from agricultural activities in watersheds (Schwantes et al. 2009). Water quality monitoring programs need to be strengthened and polluters held accountable for impacts of infringements. In-stream aquaculture is in many ways a sentinel activity for water quality, and given the substantial media attention mass mortality events generate, the *aquaculture-as-victim* discourse should be useful in justifying stronger measures against polluters for the benefit of all water users.

Third, aquaculture as a recognized stakeholder in water management must itself take greater responsibility for its impacts on water quality in public waterways and water bodies. This will require a combination of awareness raising, monitoring and regulation. All farms should be registered with local district fisheries offices, so that good practices in water management and other extension support can be provided. The DOF has, for instance, developed and promoted its own standards as a way to improve aquaculture practices, ensure food safety and protect the industry in export markets. In areas with many fish farms, water quality monitoring programs should be established in collaboration with fish farmers, as problems of self-pollution and disease are often greatest within the aquaculture sector. In some locations, fish farming should not be allowed; thus, Section 50 of the 2015 Fisheries Act gives substantial responsibility to the Provincial Fishery Committee to “determine zones or areas in which aquaculture is prohibited” (DOF 2015).

In conclusion, the claims made by various actors regarding the impacts of water uses by aquaculture are significant for the social acceptance and environmental sustainability of the sector in Thailand. On the one hand,

aquaculture discourses shape public opinion on the desirability of aquaculture development; on the other hand, these discourses also tend to reinforce rather than bridge the coalitions supporting and opposing different forms of aquaculture. The key to improving the governance of aquaculture water use is to make aquaculture farmers stakeholders in water and watershed management.

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Compliance with ethical standards

Conflict on interest The authors declare that they have no conflict of interest.

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