Aquascape ornamental industry in Malaysia: A perspective review

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Abstract. Aquascape is the skill of combining aquatic plants with soil, sand, wood, and rock to create an aquarium underwater environment either marine or freshwater as a beautiful decoration at home or in the office. The aquatic plant consisted as a major component in aquascape where the ornamental fish completed the ecosystem. However, poor management and lack of experience handling aquatic plants and ornamental fish could lead to freshwater environment issues. This study is essential to collect data on hobbyist preference on aquatic plants and ornamental fish and to monitor the aquascape practices; daily and weekly routine and effect on the environment. The main concerns that should be taking care of an aquascape are the discharge of ornamental fish, aquatic plants and effluents in the local waters that may threaten Malaysia's natural ecosystem. As far as aquatic plants are concerned, the key cause of the introduction of exotic species is from the aquarium industry, leading to invasive aquatic plant species associated with aquarium leaks. Invasive alien aquatic plants (IAAPs) endanger biodiversity due to their complex overgrowth and consequences that may be impacted to the environment and socioeconomic.

1. Introduction
In Malaysia, Aquascape is proliferating, and many social media groups have been formed with more than 80,000 registered members, such as the Facebook group “Kelab Peminat Aquascape Malaysia”. However, information on the history of aquascape hobbyists and the management of aquatic plants and ornamental fish has never been collected and researched. Aquascape is the skill of combining aquatic plants with soil, sand, wood, and rock to create an aquarium underwater environment as a beautiful decoration at home or in the office [1]. The aquatic plant consisted as a major component in aquascape where the ornamental fish completed the ecosystem. However, poor management and lack of experience handling aquatic plants and ornamental fish could lead to freshwater environment issues.

This study is essential to seek information on aquatic plants and ornamental fish and to monitor the aquascape practices; daily and weekly routine and effect on the environment. The main concerns that should be taking care of an aquascape are the discharge of ornamental fish, aquatic plants and effluents in the local waters that may threaten Malaysia's natural ecosystem. As far as aquatic plants are concerned, the key cause of the introduction of exotic species is from the aquarium industry, leading to invasive aquatic plant species associated with aquarium leaks [2]. Invasive alien aquatic plants (IAAPs)
endanger biodiversity due to their complex overgrowth and consequences that may be impacted to the environment and socioeconomic [3].

Maceda-Veiga et al., (2016) stated that the widespread release of aquarium ornamental fish into local waters is the principal contributor to biological invasion [4]. According to Banha et al., (2014), reduced indigenous fish stocks, impaired indigenous habitats and biodiversity, and damaged the natural resources of the nation are the impact comes from biological invasion between invasive species to native species [5]. Suspended particles, dissolved organic compound, nitrogen and phosphorus residues and other chemicals such as disinfectants and therapeutics a part of aquaculture effluent [6]. Aquascape effluent comes from uneaten food, faeces and various types of liquid fertilizers as a nutrient boost for plant growth that may possess a harmful effect on the environment.

Although aquascape development is quite encouraging in Malaysia, information about aquascape hobbyists has not been documented in Malaysia. This study explores the aquascape status to understand the aquascaper impact on Malaysia in particular. This study reviews potential aquascape industry in Malaysia for government agencies to establish a strategic plan for aquascape in term of environmental effect on aquatic plants, ornamental fish and effluent as guidance to the hobbyist and business owner.

2. Status of aqua-scaping industry worldwide

In recent years the term aquascape has become better known by aquarium hobbyists all over the world. According to Mukherjee et al., (2012), an aquascape is a craft of arranging aquatic plants, as well as rocks, stones, or driftwood, in an aesthetically pleasing manner within an aquarium [7]. For a simple definition, gardening underwater. Aquascape is where the aquatic flora and fauna together in an aquarium and involved photosynthesis and nitrogen cycle to maintain a natural equilibrium. Aquascape is growing rapidly in Malaysia with 2 Malaysian professional aquascaper, Josh Sim and Siak Wee Yeo have been crowned World Aquascape Champions (IAPLC) in 2019 and 2020 [8,9]. This success has brought the name of Malaysia to aquascape on the world stage and further encouraged the increase of aquascape enthusiasts in the country.

From a business perspective, aquascape in Malaysia can be categorized into three forms; ready set for sale, custom made based on customer request, and D.I.Y. (Do It Yourself) and most hobbyists tend to D.I.Y. that suited their budget and the type of design as they desired. More than 300 suppliers of ornamental fish were recorded by the Department of Fisheries Malaysia (2020b), and more than 30 physical aquascape shops were recorded by Cikgu AE (2020) in Malaysia [10,11]. In 2019, the total production of aquatic plants in Malaysia more than RM20 million, where 96% of production come from Johor [12]. Despite the demand for aquatic plants is increasing in Malaysia, no studies regarding aquascape hobbyist were documented in Malaysia.

The invasive risk of traded aquarium plant species should be a major concern and the subject of considerable surveillance and regulations. Throughout this circumstance, invasive plants from around the world are easily accessible via e-commerce. Peres et al., (2018) reported that 287 aquatic plant species for sale in Brazil, 188 were invasive species, coming from all across the world and posing a potential problem [3]. In South African coastal waters, biological invasions by aquatic alien plant species have been common and spread by one of the routes by the aquarium trade [13]. Scrivener et al., (2015) mentioned that several invasive aquatic plant species origin in the United States moved to and spread to Canada [14]. *Ludwigia grandiflora* and *Ludwigia peploides*, recorded predominantly in France as invasive aquatic plant species [1]. According to National Committee on Invasive Alien Species Malaysia (2018), *Salvinia molesta* and *Alternanthera philoxeroides*; the only two aquatic plants recorded as invasive species in Malaysia [15]. The impact of the invasive aquatic plant has reduced the biodiversity of wetlands, intervening with economic activities and negatively impacting sports and recreation activities [14], affect the balance of the macrophyte population, change the abundance of macroinvertebrate species, deprive oxygen and change the food system structure [1]. Despite the economic importance of this trade, few studies have addressed the patterns and extension of environmental problems associated with this market especially in Malaysia. Lack of reports on the
variety and status of aquatic plants used in an aquascape, whether locally produced or imported globally, that might represent as invasive alien aquatic plants (IAAPs).

The introduction into native freshwater environments of invasive alien fish through the trade of ornamental fish has been described as one of the successful forms of infiltration. This is because some reckless hobbyists and lack knowledge in the management of ornamental fish by simply releasing the fish without thinking about the environmental effects. According to a study conducted by Banha et al., (2017), more than 70% of the animals released are fish (43%) and tortoises (30%) where the reason for the discharge of animals is the lack of space/size of animals is growing (44%) and 20% want new pets [16]. In Malaysia, 27 species or 64.3% of alien fish brought to Malaysia are for aquaculture development purposes, 8 species or 19% as ornamental fish, 6 species (14.3%) for recreational fisheries and the remaining 1 species (2.4%) act as control agents biology [17]. Recent research by Saba et al., (2020) showed that nine species (39.13 per cent) of 23 freshwater fish located in 60 pet stores in Klang Valley in Malaysia had a high risk of invasion based on the Fish Invasiveness Screening Kit (FISK). There are only one of the 9 species with high potential as invasive species namely Poecilia reticulata or Guppy commonly used in an aquascape. Selection of fish in aquascape based on the small size and compatibility with planted aquariums with larger and herbivorous fish should be prevented including fish susceptible to pH fluctuations that may result from CO2. However, there are still small species commonly used in aquascapes such as Neocaridina shrimp (origin from Taiwan), cory catfish (origin from South America), algae-eater Nerite Snail (origin from Eastern Africa), and several types of tetra fish (origin from Africa and South America) which is still undocumented about the potential as an invasive species as a carrier of pathogens, especially in Malaysia.

Effluent from aquaculture has been proven by previous studies as harmful to the environment [6,18,19] and strategies to treat the effluent [20–22] has been introduced by researchers. However, no related studies on aquascape effluent have been made with the assumption only a small amount of water discharge from the aquarium. We take an example of a standard 3 feet aquarium (90cm x 45cm) with a full capacity estimated volumetric of more than 180 litres. Assume a normal aquascaper perform 50% water change once a week equal to 90 litres. Imagine if 80,000 aquascapers (based on members in Facebook Group; Kelab Peminat Aquascape Malaysia) with the same tank size and same routine, estimated nearly 7 million litres of waters were discharge per week. The need for studies on the impact of aquascape effluent becomes important to determine the impact on the environment.

3. Method of application
Most of the previous studies were based on online platform (google form and email invitation). Some researchers posted survey in media social (Facebook, Instagram, Whatsapp group) related to ornamental fish. Banha et al., (2019) in their study used an internet survey, 24 questions by Google forms and publicized in the online group dedicated to freshwater aquarium hobbyist in Portugal [23]. Tolon (2018) conducted a conjoint analysis questionnaire to ornamental fish dealers and a computer-based survey emailed to 1000 potential respondents in Turkey. Cutshaw et al., (2019) performed an online web-based survey to 304 aquarium hobbyists of 22 countries [24].

4. Recommendation
Hobbies are typical examples of activities that include fun and learning-intensive methods, and hobbyists participate in their favourite activities for comparatively long durations than are allocated to activities in the classroom [25]. Studies increasingly being carried out on different types of hobbyists, where their activities have an impact on the economy and the environment. Many types of research related to aquarium fish keeping and ornamental fish proved that this industry is competitive and profitable [23,24,26,27]. According to Pargunan & Alagappan (2020), the ornamental fish business can provide a significant contribution to rural growth in most developed countries [28]. Based on our findings, none of the aquascape studies was done in Malaysia or worldwide and it is required to perform research regarding the issues on aquatic plants, ornamental fish and aquascape effluents.
A survey needs to be done to monitor the aquascape hobbyist contributions to the economy and the effect of their activities on the environment in Malaysia. Malaysia government could establish strategic planning that mutual all parties such as;

1. Prefer on Malaysian native species in aquascape.
2. If needed to use alien species, perform S.O.P to sustain native species.
3. Organize Malaysia aquascape competition
4. Set up a professional certificate for aquascape
5. Encourage more production of ornamental fish and aquatic plant
6. Build aquascape accessories made in Malaysia to encourage the industry.

5. Conclusion
In conclusion, aquascape ornamental fish industry in Malaysia have vast potential to enhance agriculture economic growth if issues regarding of invasive aquatic plants, invasive fish species and aquascape effluent being taken care to sustain the Malaysian native fish and aquatic plant species.

References
[1] Hariyatno H, Isanawikrama I, Wimpertiwi D and Kurniawan Y J 2018 Membaca Peluang Merakit “Uang” Dari Hobi Aquascape J. Pengabdi. dan Kewirausahaan 2 117–25
[2] Peres C K, Lambrecht R W, Tavares D A and de Castro W A C 2018 Alien Express: The threat of aquarium e-commerce introducing invasive aquatic plants in Brazil Perspect. Ecol. Conserv. 16 221–7
[3] Hussner A, Stiers I, Verhofstad M J J M, Bakker E S, Grutters B M C, Haury J, van Valkenburg J L C H, Brundu G, Newman J, Clayton J S, Anderson L W J and Hofsta D 2017 Management and control methods of invasive alien freshwater aquatic plants: A review Aquat. Bot. 136 112–37
[4] Maceda‐Veiga A, Domínguez‐Domínguez O, Escribano‐Alacid J and Lyons J 2016 The aquarium hobby: can sinners become saints in freshwater fish conservation? Fish Fish. 17 860–74
[5] Banha F, Marques M and Anastácio P M 2014 Dispersal of two freshwater invasive macroinvertebrates, Procambarus clarkii and Physella acuta, by off-road vehicles Aquat. Conserv. Mar. Freshw. Ecosyst. 24 582–91
[6] Jegatheesan V, Shu L and Visvanathan C 2011 Aquaculture effluent: impacts and remedies for protecting the environment and human health Encycl. Environ. Heal. 123–35
[7] Mukherjee M and Pradeep H 2012 Aquascaping and Trade in India Congress on Urban Green Spaces (New Delhi, India)
[8] Aqua Design Amano 2019 Top of The World 2019 #01
[9] Aqua Design Amano 2020 Top of The World 2020 #01 Siak Wee Yeo
[10] Department of Fisheries Malaysia 2020 Number and area production of aquatic plants and number of culturists and workers by race and state 2019
[11] Cikgu AE 2020 List of aquascape shop in Malaysia
[12] Department of Fisheries Malaysia 2020 Value of ornamental fish and aquatic plant by state 2019
[13] Nunes M, Adams J B and van Niekerk L 2020 Changes in invasive alien aquatic plants in a small closed estuary South African J. Bot. 135 317–29
[14] Scriver M, Martinich A, Wilson C and Freeland J 2015 Development of species-specific environmental DNA (eDNA) markers for invasive aquatic plants Aquat. Bot. 122 27–31
[15] National Committee on Invasive Alien Species Malaysia 2018 Invasive Alien Species in Malaysia (Malaysia: Perpustakaan Negara Malaysia)
[16] Banha F, Diniz A and Anastácio P M 2017 The role of anglers’ perceptions and habits in biological invasions: perspectives from the Iberian Peninsula. Aquat. Conserv. Mar. Freshw. Ecosyst. 27 51–64
[17] Rahim K A B A 2012 Diversity, ecology, and distribution of non-indigenous freshwater fish in...
**Malaysia** (Universiti Putra Malaysia)

[18] Boyd C E 2003 Guidelines for aquaculture effluent management at the farm-level *Aquaculture* **226** 101–12

[19] Adler P R, Harper J K, Takeda F, Wade E M and Summerfelt S T 2000 Economic evaluation of hydroponics and other treatment options for phosphorus removal in aquaculture effluent *HortScience* **35** 993–9

[20] Farzana S and Tam N F Y 2018 A combined effect of polybrominated diphenyl ether and aquaculture effluent on growth and antioxidative response of mangrove plants *Chemosphere* **201** 483–91

[21] Tsukuda S, Christianson L, Kolb A, Saito K and Summerfelt S 2015 Heterotrophic denitrification of aquaculture effluent using fluidized sand biofilters *Aquac. Eng.* **64** 49–59

[22] Tejido-Nuñez Y, Aymerich E, Sancho L and Refardt D 2019 Treatment of aquaculture effluent with Chlorella vulgaris and Tetradesmus obliquus: The effect of pretreatment on microalgae growth and nutrient removal efficiency *Ecol. Eng.* **136** 1–9

[23] Banha F, Diniz A and Anastácio P M 2019 Patterns and drivers of aquarium pet discharge in the wild *Ecol. Indic.* **106** 105513

[24] Cutshaw L, Dalton T, Torell E, Trandafir S and Zawai N 2019 *Assessing consumer preferences for sustainability, equity, and welfare in the aquarium trade* (University of Rhode Island)

[25] Liu C C and Falk J H 2014 Serious Fun: Viewing Hobbyist Activities through a Learning Lens *Int. J. Sci. Educ. Part B Commun. Public Engagem.* **4** 343–55

[26] Arif A S M, Nusrat S, Uddin D M S, Alam D M T and Mia M R 2018 Hobbyist’s preferences and trends in aquarium fish business at Sylhet Sadar Upazila, Bangladesh *Int. J. Fish. Aquat. Stud.* **6** 392–8

[27] Alencastro L a, Degner R L and Larkin S L 2005 Hobbyists preferences for marine ornamental fish: a discrete choice analysis of ecolabeling and selected product attributes. *SPC Live Reef Fish Inf. Bull.* **15** 19–22

[28] Pargunan D and Alagappan M 2020 Determining and modelling consumers’ preferences for ornamental fish keeping *Int. J. Farm Sci.* **10** 38