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SPREAD OF INVASIVE GRASS IN INDONESIA: WITH COMPARISON TO OTHER INSTITUTIONS AND GOVERNMENT AGENCIES

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ABSTRACT

Invasive grass with dominant presence in ecosystem is often a neglected flora component. Meanwhile, the term "invasive" must be standardized, for practical purpose it must be considered as an urgent matter. Various attempts to compile invasive grass in Indonesia were conducted sporadically by several experts across generations. Scattered data along pile of literatures are awaiting to be written in order to produce a comprehensive list of invasive grass. This paper represents the first attempt in drafting the invasive grass list of Indonesia based on literatures.

Key words: alien, native grass, Indonesia, invasive, weeds.

INTRODUCTION

Grass

Grass, is a collective term for family Poaceae or Gramineae of angiosperm. Based on habit, it can be as annual or perennials, sometimes with rhizomes or stolons. Morphologically, it has cylindrical and hollow internodes with closed nodes. Leaves solitary at nodes, alternate, consisted of sheath, ligule and blade. Sheath encircling the stem with margin free and convolute. Ligule at internal junction of sheath and blade. Influorescence of spikelets often in panicle, or in spikes and racemes on a common axis, either digitately or solitary, terminal or solitary. Styles consisted of lower bract (glume) and enclosing floret which consisted of lemma, palea and sexual organ. Flower bisexual or sometimes unisexual (Lazarides 1980).

Indonesian Biodiversity

Indonesia, as an archipelago stretching on the equator, has diverse land ecosystems. Data of plants biodiversity were scattered among very few institutions. To date, there

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is no complete data about grass species inhabiting these places. If we browse the web, the result derived from typing 'Flora of Indonesia' is an article from wikipedia (Wikimedia Foundation, Inc. 2012), open to be edited at any time by enthusiast community.

On larger scale, Indonesia is located under the geographical floristic entity called as Malesia. Attached to the mainland of Asia is Malay Peninsula, extended into scattered Malay Archipelago which consist of Sumatra, Java, Borneo, Celebes, the Philippines, Moluccas Islands, Lesser Sunda Islands, and Papua New Guinea. Van Steenis (1950) divided Flora Malesiana into several regions: (1) Malay Peninsula, (2) the Philippines, (3) Sumatra, (4) Java, (5) Borneo, (6) Celebes, (7) Lesser Sunda Islands, (8) Moluccas and (9) Papua New Guinea. The first two were excluded, since in this paper discussions only focuse on Indonesia.

For more detailed information on the Flora, we can rely on 3 volumes of Flora of Java (1958, 1963 and 1968). Focusing on Poaceae, compiled by Monod de Froideville (1968), a number of 124 genera and 317 species have been recorded. Counting only the herbaceous form (excluding bamboo), the number was reduced into 116 genera and 268 species. For other islands, data were scattered among literatures (journals and books) as well as herbarium specimens.

Invasiveness

The term of 'invasiveness' has been intensively discussed in Richardson *et al.* (2000). It can be treated as naturalized or colonized plant species. Meanwhile, Catford & Downes (2010) mentioned that invasion can be as result of introduction and dispersal, as well as episodic disturbance combined with resource availability, or biotic interactions which relate to competitors release, also biotic resistance from native species.

Delimitations used here in this paper were either native or alien species which become dominant in a ecosystem, and act as transformer of habitat. As weeds, a species is considered being potentially invasive as it occupies and colonizes new areas absence before. Along with grass, there are other species judged to be invasive. According to Tjitrosoedirdjo (2005) who compiled alien plants in Indonesia, there were 1936 species, within 187 families. As many as 339 species (17%) are regarded as being invasive, of which 57 species belong to grass. Here, invasive grass is regarded as environmental weeds. At another facet, Figure 1. represents the dynamic of alien grass in Java (Sumadijaya 2011).

The list of invasive grass in Indonesia, both alien and native are in high demand at various levels. It will be a powerful scientific background to filter the grass, and being extensively used by various stake holders such as Plant Quarantine, Department of Agriculture, Ecosystem experts, Weed managers, Environmentalist, Analyst, Industry and Park managers.

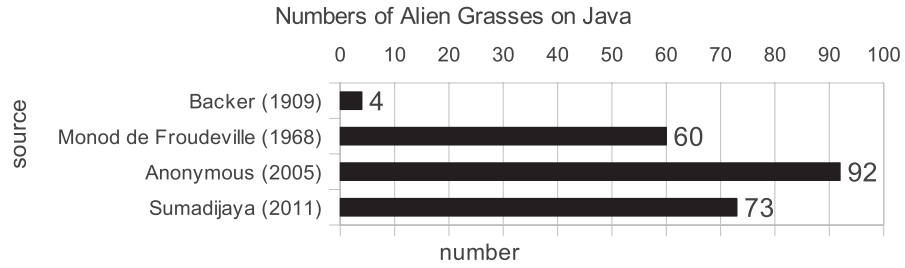

Figure 1. Dynamic count on alien grass in Java (Sumadijaya 2011)

MATERIALS AND METHOD

Compilations were resulted from 3 main sources. Backer and van Slooten (1924) focused on weeds in tea plantations, Soerjani *et al.* (1987) reported on weeds of rice , while Anonymous (2005) on Invasive Alien Species (IAS) in Indonesia.

Names were updated using 2 websites: tropicos (**Missouri Botanical Garden 2012**) and the plant list (*The Plant List* **Version 1. 2010). Infra** specific names were treated under its own species level. Distribution of each species combined from various literatures. Distributions were compiled based on region of Flora Malesiana division and only focused on Indonesian part. Illegitimate names and names without current references were excluded.

RESULTS AND DISCUSSIONS

The preliminary result for the invasive grass consisted of 92 species, based on literatures. Due to lack of detail on each island, each species existence for each region is treated according to Flora Malesiana. Adjacent islands were treated under major island vicinities (Sumatra, Java, Kalimantan, Sulawesi, and Papua) or archipelago (Lesser Sunda and Moluccas). Table 1 shows the list of invasive grass with their distribution. Plus (+) symbol represents the occurrence of a particular species in a region. Minus (-) symbol represents whether unknown or absence of a particular species in a region. Unknown status is derived because no data support for the presence of a species. Absence can be only as temporary status because in the future, there is possibility of invasion from noxious species. It can be hitch-hiked onto human, commodities or purely as unwanted contaminant dispersed by human technology through sea, air and land transportation.

Most of the grases were found in Java and vicinities (Madura, Kangean) comprising 92 species, because most of the field expeditions were conducted in Java, which resulted to a large number of specimens collected (Van Steenis 1950). The specimens then serve as a basis of various literatures published. As the center of government activities and development during colonial period, biodiversity of Java were explored in massive scale, and ended up as scientific publication.

Table 1. List of alien and native invasive grass with distribution in Indonesia

	Accepted names	S	J	K	C	P	LSI	M
1	*Apluda mutica* L.	+	+	+	+		+	
2	*Arthraxon hispidus* (Thunb.) Makino		+					
3	*Arundinella fuscata* Nees ex Buse		+					
4	*Axonopus compressus* (Sw.) P. Beauv.		+					
5	*Bothriochloa bladhii* (Retz) S.T.Blake	+	+	+	+	+	+	+
6	*Bothriochloa pertusa* (L.) A.Camus		+				+	
7	*Brachiaria distachya* (L.) Stapf		+					
8	*Brachiaria paspaloides* (Presl) C.E.Hubb.		+	+				
9	*Brachiaria ramosa* (L.) Gardn. & Hubb.		+					
10	*Centotheca latifolia* Trin.		+	+				
11	*Chloris barbata* Swartz		+	+	+	+		+
12	*Chrysopogon aciculatus* (Retz.) Trin.	+	+	+	+	+	+	+
13	*Coridochloa cimicina* Nees.		+					+
14	*Cynodon dactylon* Pers.	+	+				+	
15	*Dactyloctenium aegyptium* Richt.		+				+	
16	*Dichanthium caricosum* (L.) A.Camus		+					+
17	*Digitaria adscendens* (H. B. K.) Henr.		+					+
18	*Digitaria ciliaris* (Retz.) Koel.	+	+		+		+	+
19	*Digitaria fuscescens* (Presl.) Henr.		+					+
20	*Digitaria longiflora* Pers.		+				+	
21	*Digitaria nuda* Schumach.		+					
22	*Digitaria setigera* R. & S.		+					
23	*Digitaria ternata* (A. Rich.) Stapf		+	+	+	+	+	
24	*Digitaria violascens* Link	+	+	+	+	+	+	+
25	*Dimeria ornithopoda* Trin.		+					
26	*Diplachne polystachya* Backer.	+	+	+	+	+	+	+
27	*Echinochloa colona* (L.) Link		+				+	+
28	*Echinochloa crus-galli* (L.) P. Beauv.	+	+	+	+	+	+	
29	*Echinochloa stagnina* (Retz.) P. Beauv.		+	+	+			
30	*Eleusine indica* Gaertn.		+				+	
31	*Eragrostis amabilis* O.K.		+				+	
32	*Eragrostis bahiensis* Schultes.		+				+	
33	*Eragrostis brownii* Nees.		+					
34	*Eragrostis cilianensis* Vignolo Lutati		+					
35	*Eragrostis japonica* Trin.		+					
36	*Eragrostis pilosa* P. Beauv.	+	+	+	+	+	+	+
37	*Eragrostis unioloides* Nees.	+	+	+				
38	*Eriochloa polystachya* H.B.K.		+	+	+	+	+	
39	*Eriochloa procera* (Retz.) Hubb.		+					
40	*Hackelochloa granularis* (L.) O.K.		+					
41	*Hemarthria protensa* Nees ex Steud.		+					
42	*Heteropogon contortus* (L.) P. Beauv. ex Roemer & Schul	+	+	+	+			
43	*Hymenachne amplexicaulis* Nees.		+	+				
44	*Hymenachne aurita* Backer.		+					
45	*Hymenachne indica* Buese		+					
46	*Hymenachne interrupta* Buese		+	+				
47	*Imperata cylindrica* (L.) Beauv.	+	+	+	+	+	+	+
48	*Isachne globosa* O.K.	+	+	+	+	+	+	+
49	*Isachne miliacea* Roth.		+					
50	*Isachne pulchella* Roth. ex R. & S.		+	+		+	+	+
51	*Ischaemum rugosum* Salisb.		+					
52	*Ischaemum timorense* Kunth	+	+	+	+	+	+	+
53	*Leersia hexandra* Swartz		+	+				
54	*Leptochloa chinensis* (L.) Nees		+					
55	*Leptochloa fusca* (L.) Kunth		+					
56	*Megathyrsus maximus* (Jacq.) B.K. Simon & S.W.L. Jacol	+	+				+	
57	*Microstegium ciliatum* (Trin.) A. Camus	+	+		+	+	+	+
58	*Moorochloa eruciformis* (J.E. Smith) Griseb.		+	+	+			
59	*Oplismenus burmanii* P. Beauv.		+					
60	*Oplismenus compositus* P. Beauv.		+					+
61	*Oryza rufipogon* Griff.	+	+	+	+	+	+	+
62	*Panicum caudiglume* Hack.	+	+	+	+			
63	*Panicum luzonense* Presl.		+					
64	*Panicum malabaricum* Merr.		+					
65	*Panicum paludosum* Roxb.	+	+	+	+		+	
66	*Panicum repens* L.	+	+	+	+			
67	*Paspalidium geminatum* (Forssk.) Stapf		+					
68	*Paspalidium punctatum* (Burm.) A.Camus	+	+	+	+		+	+
69	*Paspalum conjugatum* Berg.	+	+	+	+			
70	*Paspalum longifolium* Roxb.		+			+		
71	*Paspalum scrobiculatum* L.		+	+	+	+	+	+
72	*Paspalum vaginatum* Swartz		+					
73	*Pennisetum polystachyon* (L.) Schult.		+	+				+
74	*Poa annua* L.		+					
75	*Pogonatherum crinitum* (Thunb. In Murray) Kunth		+					
76	*Polytrias indica* (Houtt.) Veldk.		+	+	+		+	+
77	*Rottboellia cochinchinensis* (Lour.) Clayton		+	+	+			+
78	*Saccharum edule* Hassk.	+	+	+		+	+	
79	*Sacciolepis indica* (L.) Chase		+	+				
80	*Sacciolepis interrupta* (Willd.) Stapf		+	+				+
81	*Sacciolepis myosuroides* (R. Br.) A. Camus		+					
82	*Sclerachne punctata* R.Br.		+	+				+
83	*Setaria barbata* (Lam.) Kunth		+			+		+
84	*Setaria clivalis* (Ridl.) Veldk.	+	+				+	
85	*Setaria pallide-fusca* (Schum.) Stapf & Hubb.		+					
86	*Setaria parviflora* (Poir.) Kerguelen		+				+	
87	*Sporobolus humilis* Presl		+				+	
88	*Sporobolus virginicus* Kunth		+	+		+	+	
89	*Themeda arguens* Hack.		+				+	+
90	*Urochloa glumaris* (Trin.) Veldk.	+	+	+	+			
91	*Urochloa mutica* (Forsk.) Stapf	+	+	+	+	+		+
92	*Urochloa reptans* (L.) Gardn. & Hubb.		+					
93	*Zoysia matrella* Merr.		+			+		+
	TOTAL	26	93	40	29	22	35	30

Note: S: Sumatra & vic.; J: Java & vic.; Kalimantan & vic; C: Sulawesi & vic; P: Papua & vic; Lesser Sunda Islands & vic; Moluccas & vic.

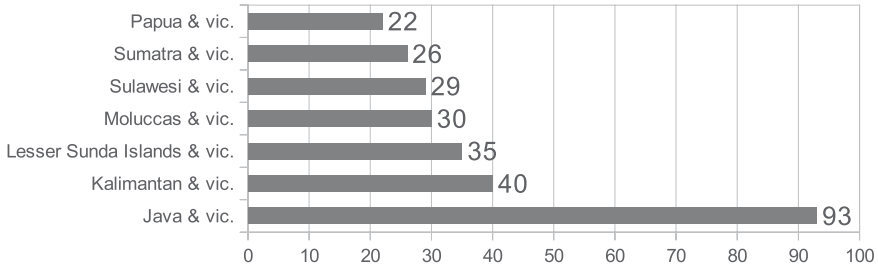

Figure 2. Comparison of invasive grass in Indonesia

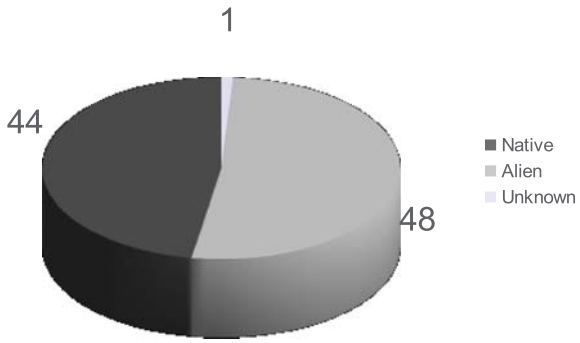

Figure 3. Comparison of invasive grass in Java: Alien, Native and Unknown Origin

The rest of the areas were Kalimantan with 40 species, Sulawesi 29 species, Papua 22 species, Lesser Sunda Islands 35 species, Moluccas 30 species and Sumatra 26 species as shown in Figure 2. Regions such as Papua, Sulawesi and Sumatra have fewer species because lack of collection compared to the area coverage while Lesser Sunda and Moluccas as island group also has a lower number of collection. It was assumed as a result of under sampling due to the surrounding oceanic barrier among these chains of islands which needs higher effort of collection. Lower specimen density ratio to larger area dimension result to unproportional exact distribution of invasive grass in Indonesia. Future exploration and expeditions should be prioritized on these places to forecast the future scenario of environmental transformation.

Ratio of native : alien : unknown origin species is 44 (47.4%) : 48 (51.6%): 1 (1%), as seen in Figure 3. Unknown distribution resulted from ancient domestication blurring the origin area of the species. Higher proportion of alien species should be considered here as hidden threat, because it has established everywhere.

One of the intriguing factor was, grass often being treated as ornamental plant by surrounding people observed in our daily life. It makes them act as 'bad boys' colonizing new abandoned areas rapidly. Controlling ornamental grass is a difficult task to be conducted because people are unaware of their invasiveness, and have no proper knowledge of recognizing particular species due to absence of accessible information. Ornamental plant can be considered as ticking biological time bomb,

because it harbors on garden and home yard, around the household. *Axonopus compressus* is an excellent example, since it escapes from people household and contaminating artificial habitats elsewhere such as crevices on parking lot, road sides, fringe of water bodies, green belt and the rest of abandoned areas.

Precaution should also be given to remote and isolated areas such as mountain peaks, since human activity already marked these places, such as *Vulpia* existence in several mountains of Java, Lombok, Borneo, Luzon and Papua New Guinea (Sumadijaya and Veldkamp 2009).

The Case of Java

Treated here, are 93 species of invasive grass in Java, consisting of 44 natives, 48 aliens and 1 unknown origin. Sumadijaya (2011) made a list (alien as well as native) of 258 grass species in Java. As many as 185 (71.7 %) were natives, with the rest of 73 (28.3) aliens and unknown origin, without any explanation on invasiveness. Five species of alien were added to the list of Sumadijaya (2011) which are *Digitaria adscendens* (H. B. K.) Henr. (Taiwan); *Diplachne polystachya* Backer from Japan, Europe, India; *Isachne pulchella* Roth. ex R. & S. from Asia; *Leptochloa fusca* (L.) Kunth from South China and India; *Setaria pallide-fusca* (Schum.) Stapf & Hubb. from India.

As a conclusion, the significant proportion of invasive (35.5%) from 262 grass species in Java should be taken seriously in the future to avoid worse environmental damage scenario.

Source from the web: Invasive in Indonesia

One of the link provided on world wide web is GISD, which stands for Global Invasive Species Database, which is an online free available premier resource of information on invasive species and their ecology, distribution, management and impacts. This database has been constructed by Invasive Species Specialist Group (ISSG) under the auspices of the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN) aiming at increasing public awareness about invasive species and facilitate prevention and manage activities by disseminating knowledge from specialists (Invasive Species Specialist Group 2008.). They also provide technical & policy advice as guidelines for the prevention of biodiversity loss caused by Alien Invasive Species.

Information extracted from Global Invasive Species Database using 2 filters, country or location: 'Indonesia' and organism type 'grass' resulted in 18 invasive species at all habitat types, consisted of 8 aliens, 7 natives, and 3 not specified, which is of course an underestimation due to lack of data. Furthermore, since it shows different status (native and alien) for some grass species, I decide not to compile it in this paper.

Source from the web: Institutions outside Indonesia

Spotting outside the Indonesia boundary, the Australian Government, through Department of Sustainability, Environment, Water, Population and Communities website has specific section on invasive species. They are concerned of

environmental biosecurity considering negative effects associated with invasive species with segmentation as: 1.) diseases, fungi and parasites, 2.) feral animals, 3.) insects and other invertebrates, 4.) introduced marine pests, and 5.) weeds (Department of Sustainability, Environment, Water, Population and Communities 2011).

United States Department of Agriculture (National Resources Conservation service 2012) provides information through National Resources Conservation Service about Invasive and Noxious Weeds. It consisted of Federal Noxious Weed List under Act of 1974 and State Noxious Weed Lists which can be varied across the area.

Invasive.org (Invasive.org: Center for Invasive Species and Ecosystem Health 2012) is a platform providing information on Invasive and Exotic Plants of North America. The website constructed by University of Georgia through Center for Invasive Species and Ecosystem Health, has Invasive Plant Atlas of The United States (Invasive.org: Center for Invasive Species and Ecosystem Health 2010) as one of the output. They also supply statistics of 2783 invasive species and 1758 species images.

All the websites are mirroring the real effort of government agencies and academic institution in dealing with invasive plants. The stake is becoming larger than before due to transformation effect of habitat followed by collapse of the ecosystems as a result.

In Indonesia, the web does not provide adequate information such as on *Indonesia Invasive Species* List - NBIN *Indonesia* (Nbinindonesia. 2008). Meanwhile, the country has national strategy on IAS (Convention on Biological Diversity 2008), but the implementation need a lot of commitment from all stakeholders, since not empowered by formal law.

CONCLUSIONS

Documentation of Indonesian Flora, focusing on invasive grass lacked details on distribution aspect. Number of invasive grass can increase any time in the future. Further compilation of literatures and herbaria specimens are needed. Furthermore, collaboration among related experts and (or) institution are strongly being encouraged. As final remarks, invasive grass is the tip of the iceberg. Early prevention will save energy, time and budget rather than restoration. In this paper, I urge every party and individual to collaborate in identifying and spotting invasive grass on nearby ecosystems in Indonesia.

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