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Distribution and Mapping of Aquatic Weeds in some Minor Canals, Gezira Scheme, Sudan (2018)

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Abstract*: Aquatic weeds have various problems in water bodies, irrigation and drainage systems around the world. Sudan have been greatly affected by aquatic weeds in many irrigated schemes such as Gezira scheme. The objective of this study was to evaluate the distribution and mapping of aquatic weeds in some minor canals in the Gezira Scheme in 2018. The study area covered six minor canals at Centre Group at Gezira Scheme; namely: Barakat I, Barakat II, Barakat III, El sonni, El ibrahim and Haj elnour which were divided into 18 sampling sites (3 sections for every canal). The distribution (percentage of frequency) of aquatic weeds of each site was determined. Geographical distribution of aquatic species was determined using the geographical positioning system (GPS). Data were subjected to descriptive analysis and to analysis of variance (ANOVA). The results showed that considerable differences in distribution of aquatic weeds throughout the year with different frequency as follows; floating weeds (50% - 61%), emergent weeds (18% - 24%), submergent weeds (0% - 13%) and bank aquatic weeds (61% - 67%).The most dominant species were Vossia cuspidata and Cynodon dactylon (100%) in both summer and winter seasons. Also, the results showed that the percentages of frequency of most aquatic weed species in the six minor canals were higher in the winter season than summer season, in addition to differences in the geographical distribution of aquatic species throughout the year. All these findings give many insights about the problems of aquatic weeds in minor canals and would be useful in the management of aquatic weed species.*

Keywords: Aquatic weeds; canals; distribution; frequency; Gezira Scheme; mapping

1. INTRODUCTION

In the early 21st century, scientists recognize the fundamental importance of plants that grow in and around the water to the structure, functioning and service provision of aquatic ecosystems [1]. Aquatic plants are usually occurring along the shores of water bodies like lakes, dams, ditches, canals and along rivers and river mouths [2] and play an important role in preservation of solar energy into chemical energy and in the development of aquatic fauna and for a continuous supplement of oxygen to water during photosynthesis. If aquatic plants increase in growth and become noxious vegetation make the water bodies inadequate, these may be called aquatic weeds [3]. Aquatic weeds can be broadly defined as unwanted and undesirable plants that vegetate and propagate in an aquatic environment [4]. All aquatic weeds contribute to reduce the efficiency of waterways. Their appearance decreases water velocity and subsequently the conveyance capacity of the canals [5]. Dense macrophyte stands can increase the flood risk by impeding river flow [6]. In lakes and irrigation headworks high evaporation rates of water are also a concern [5]. Aquatic vegetation growth can lead to water being lost from the reservoirs or channels through increased evapotranspiration and exacerbated seepage [7]. Aquatic weeds found in the intake channels may raise water levels resulting in additional seepage and spillage from the aqueducts [8]. In addition to many other serious global problems for agriculture, aquaculture, natural areas, people and economic security [9].

The three most notorious aquatic weeds; *Eichhornia crassipes* (water hyacinth), *Pistia stratiotes* (water lettuce) and *Salvinia molesta* (giant salvinia) which cause many problems in all countries around the world and nearly affecting all uses of water bodies such as for aquaculture, commercial and subsistence fishing, drinking and domestic consumption, hydropower generation, irrigation canals, navigation and recreation [10]. Water hyacinth is considered as the world's worst aquatic weed and listed as one of the top ten world's worst weeds [9].

In Sudan, aquatic weeds are considered as a major problem in irrigated schemes such as Gezira scheme, New halfa, El Suki, Gash Delta and El Rahad Schemes. The Gezira Scheme was established in 1925 and comprises more than 89000 km of canals [11]. The scheme occupies the area between the Blue Nile and White Nile south of Khartoum, between latitudes 13˚ 30 N and 15˚ 30 N, and longitudes 32˚ 15 E and 33˚ 45 E [12]. The presence of aquatic weeds was reported in the Gezira canals in 1929, only four years after the irrigation system started to operate. The infestation progressively increased, and constitute a major confusion to the irrigation system. The problem is particularly acute in the minor canals, *Abu* XXs and drains [5]. The problem of aquatic weeds in minor canals is particularly serious because of their design, construction, nutrient rich sediments and low rate flow [13]. Studies of the distribution and mapping of aquatic weeds are useful for practicing good management. Information about the current status of the aquatic weeds in

the minor canals in Gezira Scheme is scarce. So, this study was carried to evaluate the distribution and mapping of aquatic weeds in six minor canals in Center Group at Gezira Scheme, Sudan (2018).

2. Materials and Methods

2.1. Study area

The study was carried out at the Centre Group at Gezira Scheme. The study area lies between latitudes 14° 15 N and 14° 20 N, and longitudes 33° 20 E and 33° 30 E. The climate of the region is semi-desert with a mean annual precipitation of 100-250 mm/year, with the rainy season from June to October and the dry season from March to June. The mean annual evapotranspiration is 2400 mm/year. The mean annual minimum and maximum temperatures are 12 °C in January and 42°C in May, respectively. The soil of the area is characterized by heavy soil (clay 60%), with pH 8-8.5, low organic matter and nitrogen, adequate potassium and low available phosphorous [14].

2.2. The experiment

Six minor canals at Centre Group at Gezira Scheme were selected randomly for the purpose of the study. The selected minor canals were *Barakat* I, *Barakat* II, *Barakat* III, *El sonni*, *El ebrahimi* and *Haj elnour*. Each minor canal was divided into three sections; head, middle and tail. So, the study area consists of 18 sites (6 minor canals x 3 sections). Distribution (Frequency) of aquatic weeds of each site was determined and also, location maps of distribution were located. The study was conducted during winter (January, February and March) and summer (August, September and October) seasons 2018. The sites were visited once in every month for a period of three months in each season.

2.3. Distribution of aquatic weeds

Information of distribution was obtained by visual observation. This method was recommended by several researches [15]. The distribution of aquatic weeds was determined by calculation of percentage of frequency in the heads, middles and tails of minor canals as follows:

2.4. Frequency of aquatic weeds

$$F(\%) = \frac{X}{y} \times 100$$

Where:
F (%) = Frequency of aquatic weeds
X = Number of canals that consisted of aquatic weeds
Y = Total number of canals

2.5. Geographical distribution

Geographical distribution of aquatic species and locations of all minor canals under the study was determined with their Geographical Positioning System (GPS). Longitudes and latitudes of the study area were presented in maps, in addition to the distribution of all groups of aquatic weeds (Map 1 – 4).

2.6. Statistical analysis

Data were subjected to descriptive analysis and to analysis of variance (ANOVA) at $P \leq 0.5$. Significant means were separated using Duncan's Multiple Range Test (DMRT). Microsoft Excel, Statistics 8 and MSTATC were used to analyze the data.

3. Results and Discussions

3.1. Distribution of aquatic weeds

The percentage frequency of floating weeds showed that *Vossia cuspidata* (Roxb) Griff. was the most frequent species in both summer and winter seasons with the percentage frequency of (100%) in all canals under the study (Table 1). The next most frequent species was *Ipomoea aquatica* Forsk. with an overall percentage of occurrence (67%) during both summer and winter seasons, followed by *Azolla* sp. (Lam.) (60%), *Ludwigia palustris* (L.) (53%) and *Pistia stratiotes* (L.) that gave the lowest percentage of frequency (27%) in the winter season. In summer season, *Ludwigia palustris* was present with the percentage frequency of (44%) followed by *Pistia stratiotes* with the percentage frequency of (22%) and *Echinochloa stagnina* with the percentage frequency of (17%). However, *Azolla* sp. was completely absent.

Frequency of emergent weeds indicated that *Cyperus alopecuroides* Rottb. was more frequent than *Typha latifolia* Roxb. and *Polygonum glabrum* L (Table 2). It gave (40%) in the winter season and (39%) in summer season. While, the percentage of *Polygonum glabrum* increased in summer season (28%) than the winter season (7%), and *Typha latifolia* gave only (7%) in the winter season and (6%) in summer season. Submergent weeds consist of one species *Najas pectinata* (Parl.) found only in one minor canal (*Barakat* II) during winter season with the percentage of frequency (11%) (Table 3).

The bank aquatic weeds *Cynodon dactylon* (L.) Pers. gave high frequency of occurrence with an overall percentage of (100%) during both winter and summer seasons, followed by *Ipomoea hildebrandtii* L. which bear (33%) in winter season and (22%) in summer season (Table 4).

Table 1. Frequency of floating weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer seasons, 2018

Species	(%) Frequency			Mean ± SD
	Head	Middle	Tail	
Winter season				

Azolla sp.	60	60	60	60 ab ±0.00
Ipomoea aquatica	80	60	60	67 ab ±11.6
Ludwigia palustris	60	80	20	53 b ± 30.6
Pistia stratiotes	40	20	20	27 b ±11.6
Vossia cuspidata	100	100	100	100 a ±0.00
Total	340	320	260	920
Mean	68	64	52	61
SE±				8.4
CV%				23.8
Summer season				
Echinochloa stagnina	16.7	16.7	16.7	16.7 c ±0.00
Ipomoea aquatica	100	66.7	33.3	66.7 ab ±33.3
Ludwigia palustris	50	50	33.3	44.4 bc ±9.6
Pistia stratiotes	33.3	16.7	16.7	22.2 c ±9.6
Vossia cuspidata	100	100	100	100 a ±0.00
Total	300	250	200	750
Mean	60	50	40	50
SE±				8.2
CV%				28.2

* Means followed by the same letter(s) are not significantly different ($P \leq 0.05$) accordingly Duncan's Multiple Range Test.

Table 2. Frequency of emergent weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer seasons, 2018

Species	**(%) Frequency**			**Mean ± SD**
	Head	**Middle**	**Tail**	
Winter season				
Cyperus alopecuroides	20	40	60	40 a ±20.0
Polygonum glabrum	0.0	0.0	20	7 b ±11.6
Typha latifolia	0.0	0.0	20	7 b ±11.6
Total	20	40	100	160
Mean	6.67	13.3	33.3	18
SE±				3.8
CV%				37.5
Summer season				
Cyperus alopecuroides	50	33.3	33.3	38.9 a ± 9.6
Polygonum glabrum	16.7	33.3	33.3	27.8 a ± 9.6
Typha latifolia	0.0	0.0	16. 7	5.33 a ± 0.00
Total	67	67	83	217
Mean	22	22	28	24
SE±				6.3
CV%				45.8

* Means followed by the same letter(s) are not significantly different ($P \leq 0.05$) accordingly Duncan's Multiple Range Test.

Table 3. Frequency of submergent weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter, 2018

Species	**Frequency (%)**			**Mean ± SD**
	Head	**Middle**	**Tail**	
Najas pectinata	0	16.7	16.7	11 ± 9.6
Total	0	16.7	16.7	11
Mean	0	16.7	16.7	11

Table 4. Frequency of bank aquatic weeds in six minor canals in Centre Group at Gezira Scheme, Sudan in winter and summer, 2018

Species	**Frequency (%)**			**Mean ± SD**
	Head	**Middle**	**Tail**	
Winter season				
Cynodon dactylon	100	100	100	100 a ± 0.00

Ipomoea hildebrandtii	20	40	40	33 b ± 11.6
Total	120	140	140	400
Mean	60	70	70	67
SE±				6.7
CV%				12.3
Summer season				
Cynodon dactylon	100	100	100	100 a ± 1.0
Ipomoea hildebrandtii	33.3	0	33.3	22 b ± 19.2
Total	133	100	133	366
Mean	67	50	67	61
SE±				7.8
CV%				22.3

* Means followed by the same letter(s) are not significantly different ($P \leq 0.05$) accordingly Duncan's Multiple Range Test.

Bank aquatic weeds also included many species prevailing in different percentages of frequency, such as *Xanthium stramarium*, *Ischaemum afrum*, and *Indigofeora hochsteteri.*

Generally, the frequency of floating weeds was higher in winter season (61%) than summer season (50%) (Table 1). Also, bank aquatic weeds reached a high percentage of occurrence in winter season (67%) compare with the summer season (61%) (Table 4). Submergent weeds disappeared in summer season. While, emergent weeds increased in summer season (24%) than the winter season (18%) (Table 2). The result showed that the percentages of frequency of most aquatic weed species in the six minor canals were higher in the winter season than summer season (Table 1 – 4).

3.2. Geographical distribution

The location maps of distribution of all groups of aquatic weeds were presented in (Map 1-4) as follows; distribution of floating weeds (*Azolla sp., Ipomoea aquatica, Ludwigia palustris, Pistia stratiotes, Vossia cuspidata* and *Echinochloa stagnina*) (Map. 1), distribution of emergent weeds (*Cyprus alpecuroides, Polygonum glabrum* and *Typha latifolia*) (Map. 2), distribution of submergent weeds (*Najas pectinata*) (Map. 3) and distribution of bank weeds (*Cynodon dactylon* and *Ipomoea hildebrandtii)* (Map. 4).

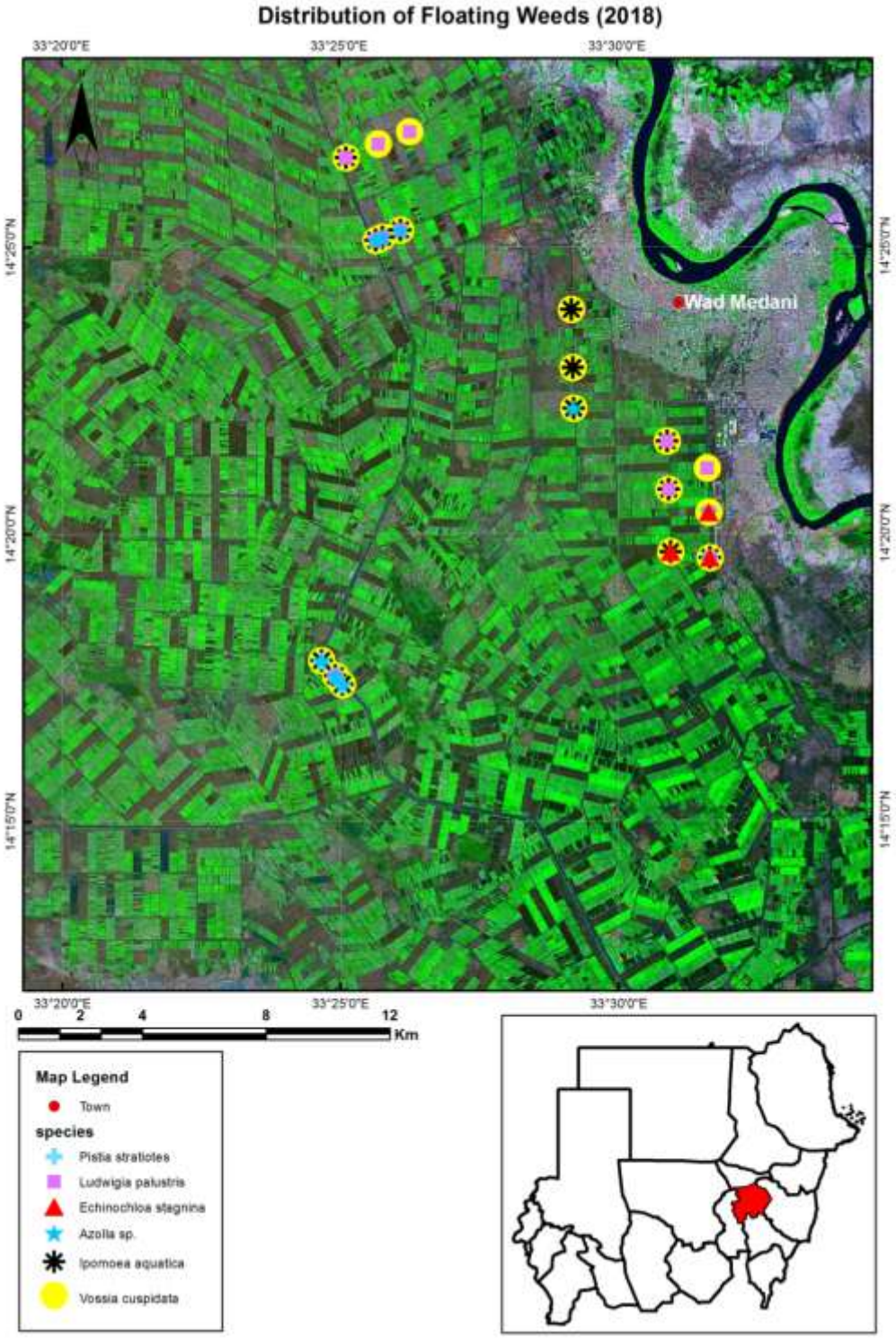
Reference [16] pointed that the frequency not only shows the importance of species, but also the evenness of spatial distribution in the community. In this study, the percentage frequency of aquatic weeds showed that *Vossia cuspidata* and *Cynodon dactylon* was the highest percentage of frequency. While, the species *Typha latifolia* and *Najas pectinata* were the minimum percentage of frequency. The results indicated that the frequency is essential to know the distribution and importance of species in the community.

The frequency of floating and bank aquatic weeds were the highest among other groups of aquatic weeds. This is probably due to the modification of the bottom of canals due to siltation and sometimes accumulations of submersed weeds, thus creating a suitable habitat for a species such as *Vossia cuspidata*, *Cynodon dactylon*, and *Ipomoea aquatica*. In addition to some bank aquatic weed species such as *Ischaemum afrum* and *Xanthium stramarium* were the commonest in the banks of canals. Most of the canals were free of submerged weeds, possibly because of their hydrological characteristics of minor canals such as the depth with fast current and also mechanical clearance. This also reported by [17, 18].

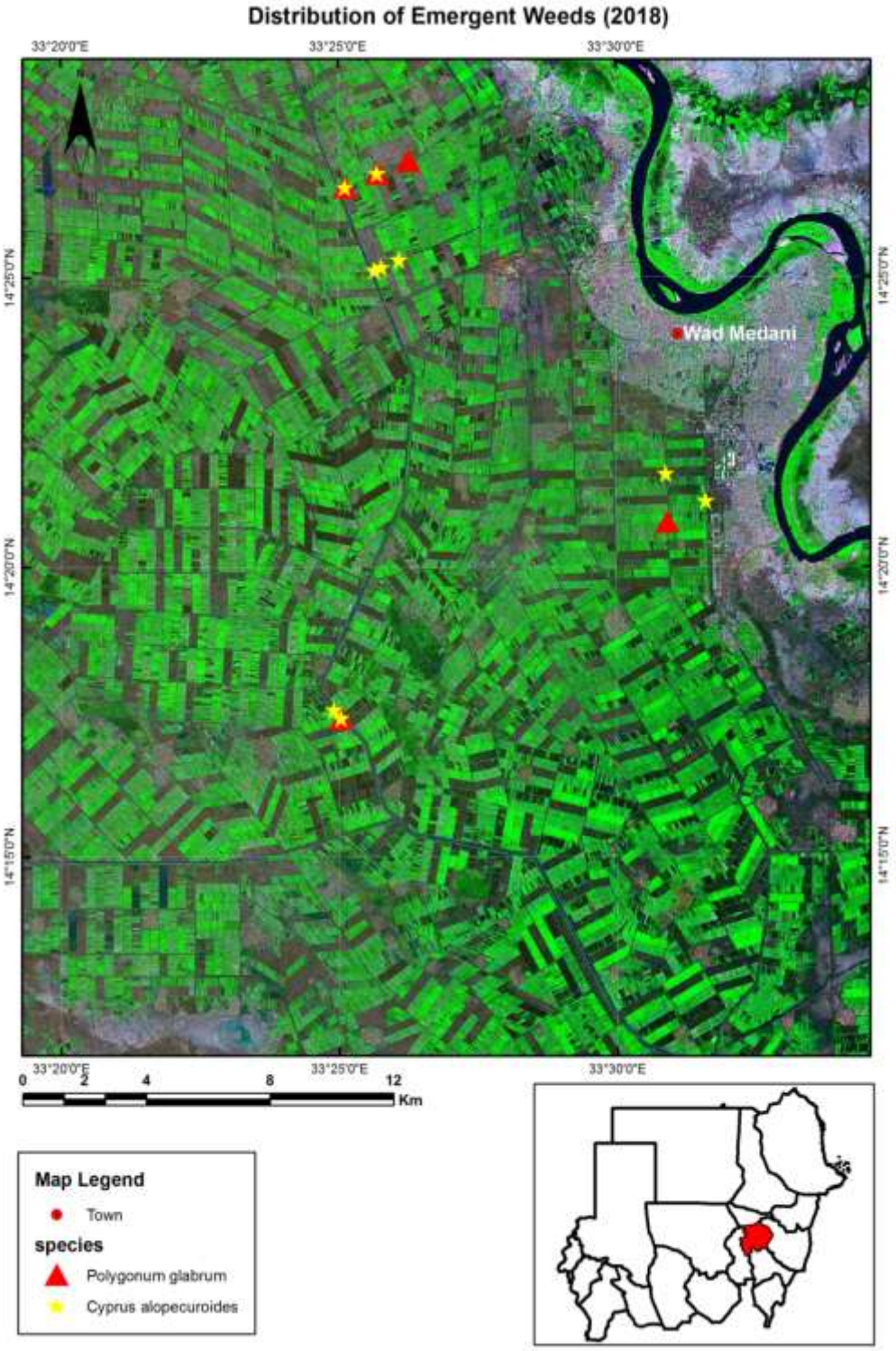
The results showed that the percentage frequency of most aquatic species in the canals was higher in the winter season than summer season. This also reported previously by [17] and was attributed mainly to the turbidity of the water in summer season compared with the clearest water in winter season.

CONCLUSION

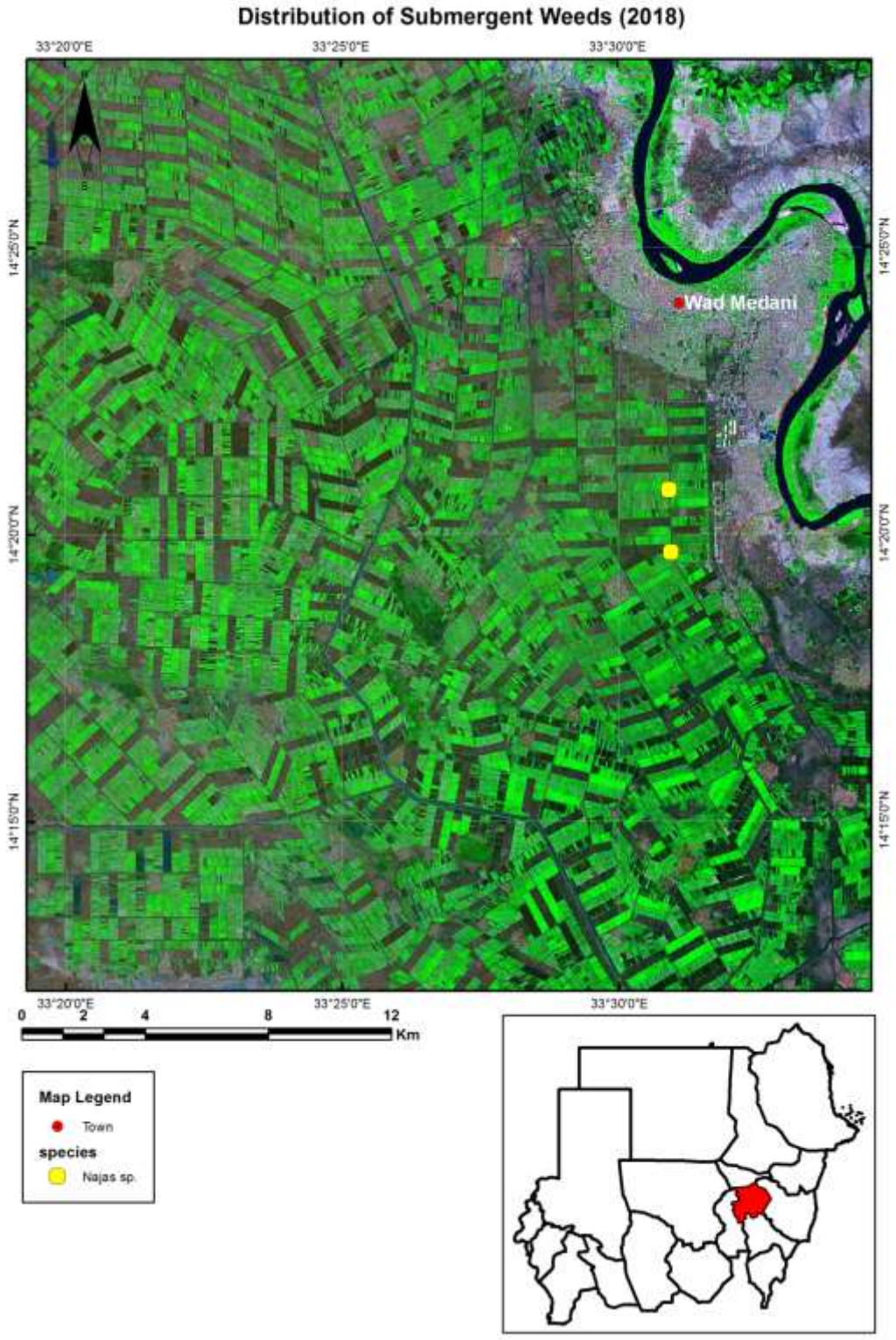
The study showed that the community structure of aquatic weeds in minor canals of Gezira scheme consist of different groups of aquatic weeds with many differences in the vegetation and geographical distribution throughout the year, this may be attributed to many factors such as turbidity and hydrological characteristics of minor canals which may affect the growth and distribution of aquatic species during summer and winter season.



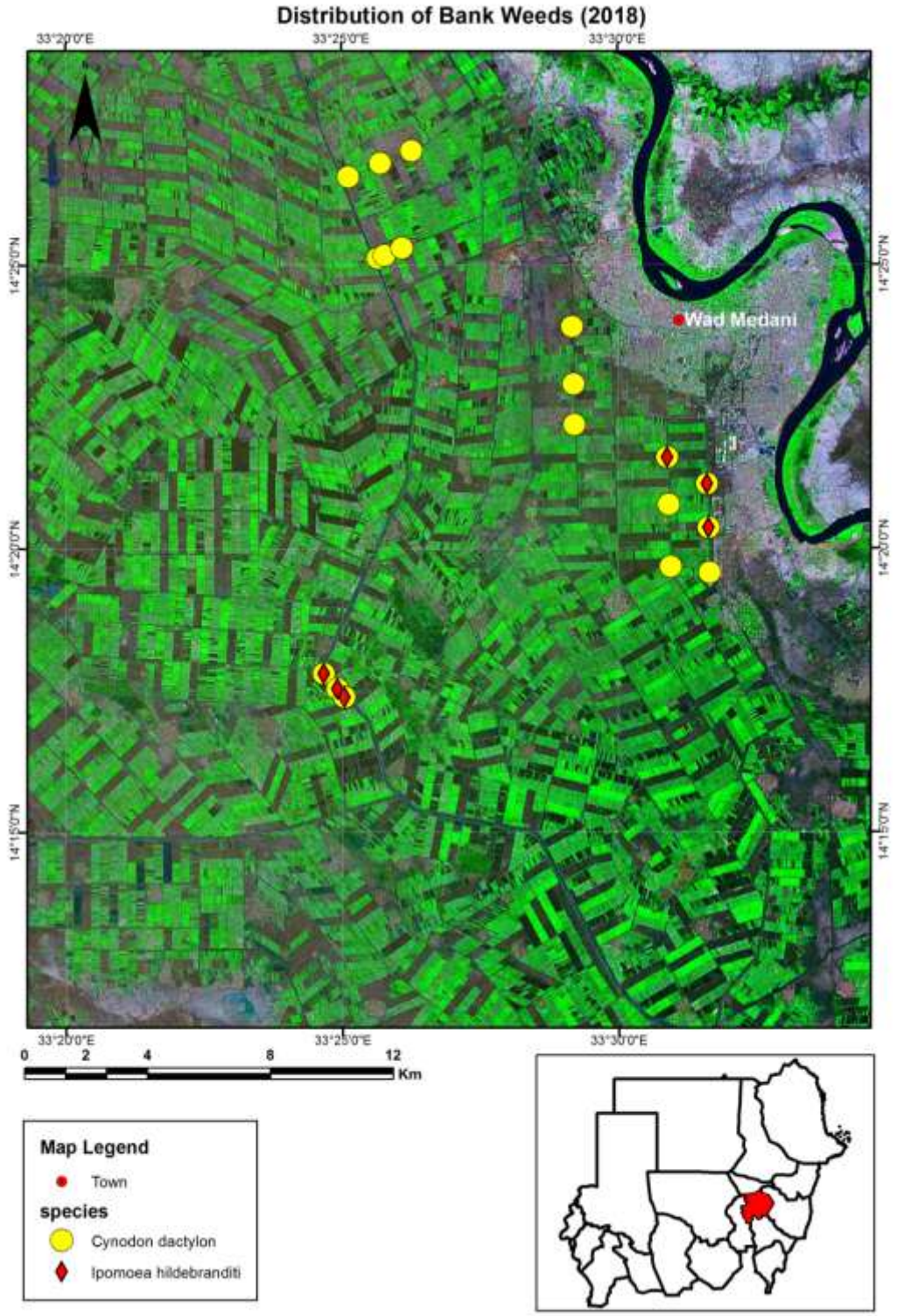
Map 1. Geographical distribution of floating weeds (*Azolla* sp. – *Ipomoea aquatica* - *Ludwigia palustris* - *Pistia stratiotes* - *Vossia cuspidata* – *Echinochloa stagnina*).



Map 2. Geographical distribution of emergent weeds (*Cyprus alpecuroides – Polygonum glabrum*).



Map 3. Geographical distribution of submergent weeds (*Najas pectinata*).



Map 4. Geographical distribution of bank weeds (*Cynodon dactylon –Ipomoea hildebrandtii).*

REFERENCES

[1] Chambers, P. A., Lacoul, P., Murphy, K. J. and Thomaz, S. M. (2008). Global diversity of aquatic macrophytes in freshwater. *Hydrobiologia* 595: 9–26.

[2] Aloo, P., Ojwang, W., Omondi, R., Njiru, J.M. and Oyugi, D. (2013). A review of the impacts of invasive aquatic weeds on the biodiversity of some tropical water bodies with special reference to Lake Victoria (Kenya). *Biodiversity Journal.* 4 (4), 471 – 482.

[3] Bhan, V.M. and Sushilkumar, J.S. (1996). Eco-friendly approaches in aquatic weed management. *In*: proceedings of workshop on "*Aquatic weeds-problems and management* " held at Bangalore (Karnataka), 5-7 June 1996. Varma, C.V.J.(eds.) 191-201.

[4] Lawrence, J.M. (1968). Aquatic weed control in fish ponds, paper no. E-1, In the proceeding of the world symposium on warm water pond fish cultures [FAO fisheries report 44] (Food and Agricultural Organization of United Nations, Rome), vol. 5, pp. 76-91.

[5] Ahmed, S.T.E. and Abdalla, E.H. (1992). Aquatic weeds in Sudan gravity irrigation systems: problems, resolutions and financial and policy implications. Irrigation Management Network Paper 13(3):23-28. Overseas Development Institute, London, UK.

[6] Thouvenot, L., Haury, J. and Thiebaut, G. (2013). A success story: water primroses, aquatic plant pests. *Aquat. Conserv*. 23, 790–803.

[7] Brabben, T.E. (1993). Research needs for Aquatic plant management in developing countries. *Journal of Aquatic Plant Management.* 31: 214-217.

[8] Robson, T.O. (1973). The control of aquatic weeds (2nd edn.) Bulletin Ministry of agriculture, fish and food, London,194,54.

[9] Ryan, M.W. and John, D.M. (2009). A review of the global status of aquatic plants, Aquatic Plants Their Uses and Risks. International Plant Protection Convention (IPPC).

[10] Charudattan, R. (2001). Are we on top of aquatic weeds? Weed problems, control options, and challenges. A talk presented at an international symposium on the World's Worst Weeds, organized by the British Crop Protection Council, Brighton, United Kingdom.

[11] Coates, D. and Redding-Coates, T.A. (1981). Ecological problems associated with irrigation canals in the Sudan with particular reference to the spread of Bilharziasis, Malaria, and aquatic weeds and the ameliorative role of fishes. *International Journal of Environmental studies.* 16:207-212.

[12] Eldaw, A.M. (2004). The Gezira Scheme: Perspectives for Sustainable Development. University of Gezira. German Development Institute. die@die-gdi.de www.die-gdi.de ISBN 3-88985-262-9.

[13] Idris, I.M. (1999). Impact of aquatic weeds on performance of irrigation canals. Ph.D. Thesis. University of Gezira.

[14] Elbasher, O.A. (2016). Vermination of climate changes using rainfall and temperature as indicators and its impacts on agricultural production in the arid zone of Sudan (1981-210). Ph.D. Thesis, University of Gezira, Sudan.

[15] Yousif, M. Y. H. (2019). Composition, Abundance and Distribution of Aquatic Weeds in Minor and AbuXX Canals, Rahad Scheme, Sudan (2017-2018). M Sc. Thesis, University of Gezira, Sudan. Pp .35.

[16] Deng, H.B., Zhan-Qing, H., Ping, J. and Qing-li. (2000). Species frequency of communities along northern slope of changbai mountain, Northeast china. *Journal of Forests Research.* 11: 187-190.

[17] Abdel Gadir, H. (1987). Annual Report of the Gezira Research Station. Season 1986/87. Ministry of Agriculture. Agricultural research corporation.

[18] Abdel Gadir, H. (1988). Aquatic weeds. Annual Report of the Gezira Research Station. Season 1988/89. Ministry of Agriculture. Agricultural research corporation.