

ECOLOGICAL STATUS AND ENVIRONMENTAL PROTECTIVE ROLE OF *AVICENNIA OFFICINALIS* IN THE VULNERABLE COASTAL REGIONS OF BANGLADESH: AN OVERVIEW

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ABSTRACT

Bangladesh is a sub-tropical deltaic country situated at the mouth of funnel shaped Bay of Bengal. The coastal regions of this country is extremely vulnerable to frequently occurring natural disasters like tropical cyclones, tidal surges, wave energy, land erosion, and salt intrusion. *Avicennia officinalis* is a pioneer mangrove tree species which plays significant ecological role in maintaining sustainable vegetation both in the Sundarbans and coastal plantations in Bangladesh, thereby protecting the coastal people from natural calamities. New land accreted at the rate of 35km²/year in the coastal regions for the last few decades. So, *A. officinalis* remains one of the principal species for coastal afforestation, thereby playing its protective role in perpetuity. Salinity in the coastal regions of Bangladesh increased as a consequence of climate change and reduced fresh water flow from the upstream. *A. officinalis* emerged as an important mangrove species for coastal afforestation because of its tolerance to increased salinity. The species played significant role in coastal land stabilization. It also created employment opportunities for the local people in the coastal afforestation programme, thereby providing socio-economic as well as environmental protection to the people inhabiting the coastal regions of Bangladesh.

Key words: *Avicennia officinalis*, Climate change, Coastal region, Natural disasters, Protection.

Introduction

Bangladesh is a sub-tropical and deltaic country (Huque *et al.*, 2001; Alam and Uddin, 2013; Rasel *et al.*, 2013) situated between 20° 35' and 26° 38' N latitudes and between 88° 01' and 92° 41' E longitudes (Alam and Uddin, 2013; Hassan *et al.*, 2014). The country is located at the mouth of funnel shaped (Fig. 1, Fig. 2) Bay of Bengal

(Rahman and Biswas, 2011). There is about 711 km long coastline in Bangladesh (Minar *et al.*, 2013) which extends about 150 km offshore (Rasel *et al.*, 2013).

Coastal regions of Bangladesh extend 20% of the total land area and 30% of the cultivable land of the country (Minar *et al.*, 2013; Rasel *et al.*, 2013). 80% land is below 1 m amsl (Alam and Uddin, 2013). About 41.8

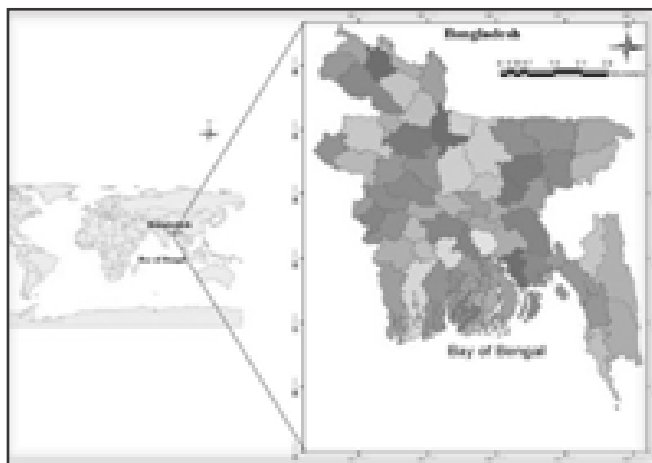


Fig. 1: Bay of Bengal (Minar *et al.*, 2013)

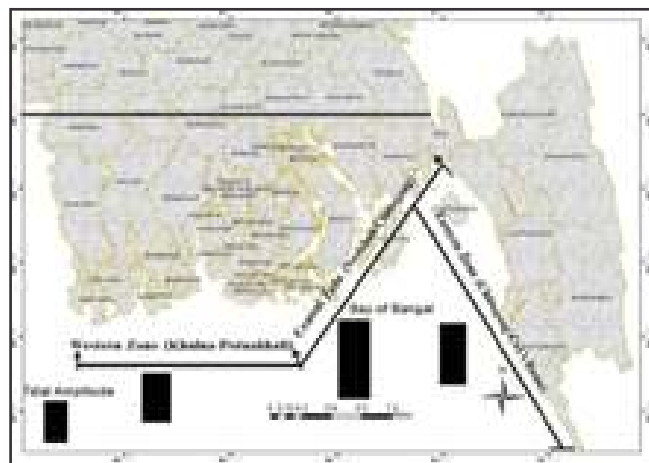


Fig. 2: Tidal amplitudes of funnel shaped Bay of Bengal (Flierl and Robinson, 1972)

Avicennia officinalis helps to reduce salt intrusion, therefore, contributing in crop production in the coastal region of the country.

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million people are residing in these regions. It is expected that total population grows up to 57.9 million by the year 2050 (Minar *et al.*, 2013). Socio-economic and environmental life of coastal people are largely dependent on coastal natural resources. Coastal regions of Bangladesh are highly vulnerable to natural calamities like tropical storms, tidal surges, cyclones etc. In addition, soil and river bank erosion, deposition, accretion, and salt intrusion into the agricultural crop fields are of frequent occurrence (Rahman and Biswas, 2011). Therefore, protection against natural disasters is of paramount importance. Sundarbans -the world's largest tract of mangrove forest stands against frequently occurring natural calamities in the coastal areas of the country (Kathiresan and Bingham, 2001; Siddiqi, 2001; Rahman and Biswas 2011). *Avicennia officinalis* has been growing as an exclusive pioneer mangrove tree species in the Sundarbans of Bangladesh (Siddiqi, 2001). Therefore, an attempt was taken to know the ecological status and environmental protective role of *A. officinalis* in the vulnerable coastal regions of Bangladesh.

Material and Methods

To write this manuscript, almost all of the available published articles, books, conference and seminar proceedings etc. were collected. All the information and data pertinent to the issues of the vulnerability of the coastal regions of Bangladesh, ecological status and environmental protective role of *A. officinalis* were compiled and analyzed. An intensive visit to the Sundarbans and coastal plantations was done to observe the ecological and regeneration status as well as role of *A. officinalis* in land stabilization in the coastal regions of Bangladesh.

Results and Discussion

Vulnerability of Coastal regions of Bangladesh

Being funnel shaped, tidal amplitudes of the Bay of Bengal is very high (Fig. 2). It is about 3 m in the west and about 5 m in the central region (very active), and decreases towards the eastern coast (Flierl and Robinson, 1972). Bay of Bengal is known as a breeding ground of tropical cyclones (Rahman and Biswas, 2011). In the last 100 years, 508 tropical cyclones have originated from the Bay of Bengal (Government of Bangladesh, 2008). As many as 900,000 people died in the coastal regions due to natural disasters in the last 35 years. 53% of the coastal areas are being affected by salt intrusion from the sea (Minar *et al.*, 2013; Mustari and Karim, 2014). Coastal aquifers are also affected by high salinity (Minar *et al.*, 2013). Salinity in the coastal regions of Bangladesh is increasing due to sea level rise (Solomon, 2007), decrease in fresh water flow from

upstream (Shafi, 1982; Gopal and Chauhan, 2006) and low amount of precipitation during the recent time due to climate change (Christensen *et al.*, 2007). Therefore, salinity affects mangrove ecosystem, agricultural crop production (Rabbani *et al.*, 2013) and drinking water in the coastal regions (Basar, 2012). Moreover, land erosion, river bank slumping and sediment deposition are continuous processes in the coastal regions of Bangladesh (Alam and Uddin, 2013; Mustari and Karim, 2014).

Global distribution of *Avicennia officinalis*

Avicennia officinalis L. is distributed (Fig. 3) in the mangrove forests of India, Bangladesh, Sri Lanka, Myanmar, Andaman Island, Thailand, Malaysia, Indonesia, the Philippines, New Guinea, and north-eastern Australia (Tomlinson, 1994; Mahmood, 2015).

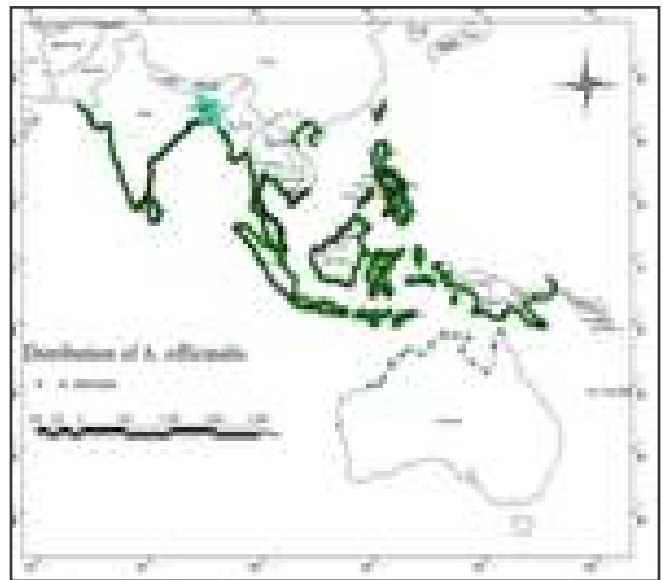


Fig. 3: Global distribution of *A. officinalis* (Spalding *et al.*, 1997)

Ecological status of Avicennia officinalis in Bangladesh

There are three distinct mangrove vegetation (Fig. 4) in Bangladesh. The Sundarbans is the largest coastal wetland (Gopal and Chauhan 2006) and the single largest tract (6017 km²) of natural mangrove forest situated in the south-west corner of Bangladesh (Minar *et al.*, 2013). There are 85.4 km² natural mangrove forest named as Chokoria Sundarbans located in the south eastern coast of the country (Das and Siddiqi 1985). Based on the level of salinity, the Sundarbans has been divided into less saline (LS), moderate saline (MS) and strong saline (SS) zones having salinity from 0.5-5 ppt, 5-18 ppt and 18-30 ppt respectively (Siddiqi, 2001). *A. officinalis* is an exclusive cryptoviviparous mangrove and pioneer tree species in the phytosuccessional processes in the Sundarbans (Naskar and Bakshi, 1987; Zabala, 1990; Siddiqi, 2001; Hossain, 2015). The species grows in the three saline zones

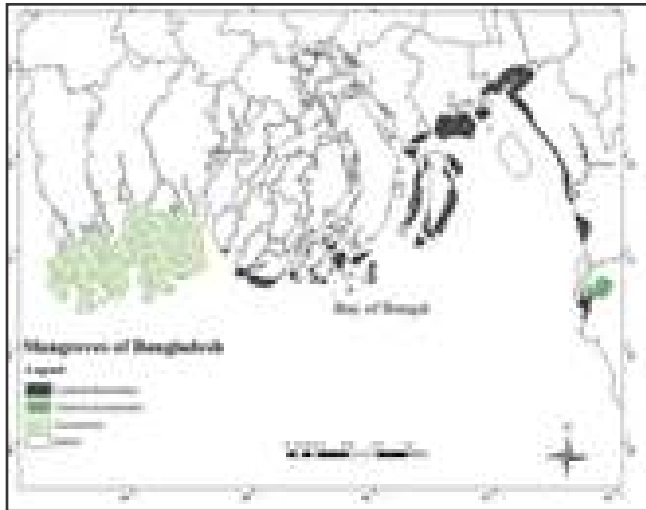


Fig. 4: Coastal mangroves in Bangladesh (Papry, 2014)

of the Sundarbans (ODA, 1985; Untawale, 1987). In addition, *A. officinalis* is the second principal tree species of those coastal plantations (Das and Siddiqi, 1985; Papry, 2014; Siddiqi, 2001). *A. officinalis* planted in mixture with *Sonneratia apetala* to reduce infestation of *S. apetala* by *Zeuzera conferata* (Zabala, 1990). It is planted mostly on strong saline substrate in the coastal areas (Das and Siddiqi, 1985; Siddiqi and Khan, 1990; Siddiqi, 2001). *Avicennia officinalis* tolerates salinity up to 90 ppt (Cintron *et al.*, 1978).

Protective role of *Avicennia officinalis* in Bangladesh

Protective role against natural disasters: Mangroves serve as natural barriers against tropical cyclones and tidal surges (FAO, 1994; Tanaka *et al.*, 2007; Lyche, 1991). The Sundarbans protects the south western part of Bangladesh against frequently occurring tropical storms, tidal surges and also protects the coastal agricultural lands against salt intrusion from the sea (Ali, 1998; Kathiresan and Bingham, 2001). Being a pioneer tree species in mangrove succession, *A. officinalis* appears first on the newly accreted lands (Fig. 5) in the Sundarbans.

This species created favorable habitat conditions for the species of next seral stages (Fig. 6) such as *Heritiera fomes*, *Excoecaria agallocha*, *Ceriops decandra* etc. Thus, the Sundarbans maintains a continuous vegetation, thereby creating a protective barrier against frequent natural calamities. Experiencing from the protective role of the Sundarbans, Bangladesh Forest Department started coastal afforestation programme with *Sonneratia apetala* and *Avicennia officinalis* in 1966 to provide protection to the coastal people against frequently occurring tropical cyclones, tidal surges, land erosion, and salt intrusion from the sea (Das and Siddiqi, 1985; Saenger and Siddiqi, 1993). About 52% of *S. apetala* in the coastal plantations were



Fig. 5: *A. officinalis* on newly accreted land



Fig. 6: Next seral species under *A. officinalis*

affected stem borer *Zeuzera conferata* (Islam *et al.*, 1989). Consequently, *Avicennia officinalis* became very important mangrove species for establishing a protective green belt along the coastline of Bangladesh.

Role in coastal land stabilization: Mangroves are important land builders (Dawes, 1981). *A. officinalis* naturally grows alongside the river banks (Fig. 7), thereby reducing river bank erosion which is very common phenomenon in coastal regions.

A. officinalis stabilizes coastlines by preventing soil erosion caused by tidal current, and wave energy (Thampany *et al.*, 2006). Bangladesh is the most densely populated country in the world. Moreover, a 45 cm sea level rise may dislocate 35 million people from the coastal regions by the year 2050 (Alam and Uddin, 2013) which will further aggravate the land crisis in the country. Therefore, *A. officinalis* has been playing a significant role by stabilizing the coastal lands which can be used for crop cultivation. This will ultimately be helpful for the socio-



Fig. 7: *A. officinalis* stabilizes river bank



Fig. 8: Dense growth of *A. officinalis*

economic development of the coastal people. Approximately 444 acres of newly accreted land have so far been brought under coastal afforestation programme of these, 110 acres of stable land have already been transferred to the Ministry of Land, the Government of the People's Republic of Bangladesh (Forest Department).

Role against salt intrusion: Tidal surges and sea level rise caused salt intrusion into the agricultural lands in the coastal regions of Bangladesh (Rabbani *et al.*, 2013). Protective green belts established by dense growth of *A. officinalis* (Fig. 8) reduce the force tidal surges, and wave energy. Wave energy is reduced to half while passing through a fifty-meter width of mangrove vegetation (Rahman and Biswas, 2011). Therefore, *A. officinalis* helps reduce salt intrusion, thereby contributing crop production in the coastal regions of the country.

Prospects of *Avicennia officinalis* in Bangladesh

New land is being accreted at a rate of 35 km²/year in

the coastal areas of the country (McConchie 1990). If the coastal afforestation programme continues, *A. officinalis* will remain as an important mangrove tree species in that plantation programme. Moreover, with the increasing in salinity in the coastal regions, *A. officinalis* is becoming more important mangrove species for coastal plantation (MacMillan, 1974).

Conclusion

The coastal regions of Bangladesh extremely vulnerable to frequently occurring natural disasters. *A. officinalis*, being a pioneer species in mangrove succession, has been playing significant role to maintain sustainable vegetation cover in the coastal regions, thereby providing protection to the coastal people against tropical storms, tidal surges, wave energy, land erosion, and salt intrusion from the sea. *A. officinalis* ultimately provides socio-economic and environmental protection to the coastal people.

बंगलादेश के संवेदनशील तटवर्ती क्षेत्रों में एविसीनिया ऑफिसिनेलिस का पारिस्थितिकीय स्तर और पर्यावरणीय संरक्षी

भूमिका: एक अवलोकन

मो. रबिउल अलाम, महमूद हुसैन, मो. मसूदूर रहमान, तनय विश्वास, शमीमा नसरिन और एम.एस.टी. लूलू रेहयान खुशी

सारांश

बंगलादेश चिमनी के आकार के बंगाल की खाड़ी के मुहाने पर स्थित एक उपउष्णकटिबंधीय त्रिकोणीय देश है। इस देश का तटवर्ती क्षेत्र उपउष्णकटिबंधीय तूफानों, ज्वारीय लहरों, तरंग ऊर्जा, भू-क्षरण एवं लवण प्रवेश जैसी बार-बार होने वाली प्राकृतिक आपदाओं के प्रति अत्यन्त संवेदनशील है। एविसीनिया ऑफिसिनेलिस ऐसी एक अग्रणी कच्छवनस्पति वृक्ष प्रजाति है, जो बंगलादेश में तटवर्ती रोपणों और सुन्दरवन दोनों में पोषणीय वनस्पति का अनुरक्षण करने में महत्वपूर्ण पारिस्थितिकीय भूमिका अदा करती है। इस प्रकार यह प्राकृतिक आपदाओं से तटवर्ती लोगों की सुरक्षा करती है। गत कुछ दशकों से तटवर्ती क्षेत्रों में 35 वर्ग कि.मी. प्रति वर्ष की दर पर नमी भूमि में अभिवृद्धि हुई है। अतः एविसीनिया ऑफिसिनेलिस तटवर्ती वनीकरण

के लिए प्रधान प्रजातियों में से एक रही है, इस तरह निरन्तरता में अपनी संरक्षणात्मक भूमिका निभा रही है। बंगलादेश के तटवर्ती क्षेत्रों में जलवायु परिवर्तन के परिणाम के रूप में लवणता बढ़ी है और प्रति स्रोत से स्वच्छ जल प्रवाह घटी है। वर्धित लवणता के प्रति अपनी सहनशीलता के कारण तटवर्ती वनीकरण के लिए *एविसीनिया ऑफिसिनेलिस* एक महत्वपूर्ण कच्छ वनस्पति प्रजाति के रूप में उभरी है। प्रजाति ने तटवर्ती भूमि स्थिरीकरण में महत्वपूर्ण भूमिका अदा की है। इसने तटवर्ती वनीकरण कार्यक्रम में स्थानीय लोगों के लिए रोजगार के सुवअसर भी सृजित किए हैं। इस प्रकार यह बंगलादेश के तटवर्ती क्षेत्रों में निवास कर रहे लोगों के लिए सामाजिक-आर्थिक साथ ही साथ पर्यावरणीय सुरक्षा उपलब्ध करा रही है।

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