MONASH
University

MONASH
SUSTAINABLE
DEVELOPMENT
INSTITUTE

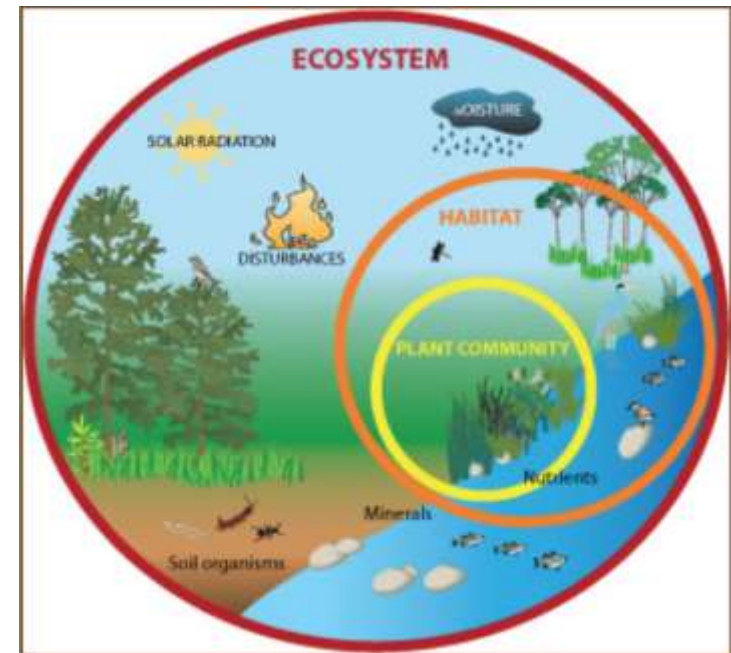# UNACKNOWLEDGED VALUES OF URBAN ECOSYSTEMS: AN ANALYSIS FOR DHAKA CITY

PRESENTER: NAEEMA JIHAN ZINIA

DOCTORAL RESEARCHER

August 25, 2017

GROUP
OF EIGHT
AUSTRALIA

ECOSYSTEM

"A dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit" of which humans are an integral part (MA, 2005a).

ECOSYSTEM SERVICES

Ecosystem services are the <u>benefits (goods and services)</u> that are derived from ecosystem functions which <u>contribute to human well-being</u> directly or indirectly (Costanza et al, 1997; Daily, 1997; de Groot et al, 2002; MA, 2005b; TEEB, 2010a).

MONASH
University

(1) Provisioning Services

Water
Food
Wood, Fiber, other Raw materials
Ornaments & souvenirs
Medicins

(2) regulating services

Regulating Services
Carbon storage/air quality
climate regulation
Storm protection
Flood prevention
Waste treatment
Biological control

(3) Cultural & Amenity Services

(4) Habitat (supporting) services

RESEARCH BACKGROUND

- ❑ The development process of the Bangladesh delta has gained momentum.

- ❑ In its path of progression it faces multi-dimensional challenges related to, among others, population growth, rapid urbanization, land use change and natural hazards compounded with likely climate change.

- ❑ Social, economic and environmental aspects, especially in urban areas, are under pressure.

- ❑ Dhaka, the capital city of Bangladesh, is the hub of socio-economic and cultural activities of the country.

- ❑ As this city is growing, managing its ecosystem services is becoming increasingly complex.

MONASH University
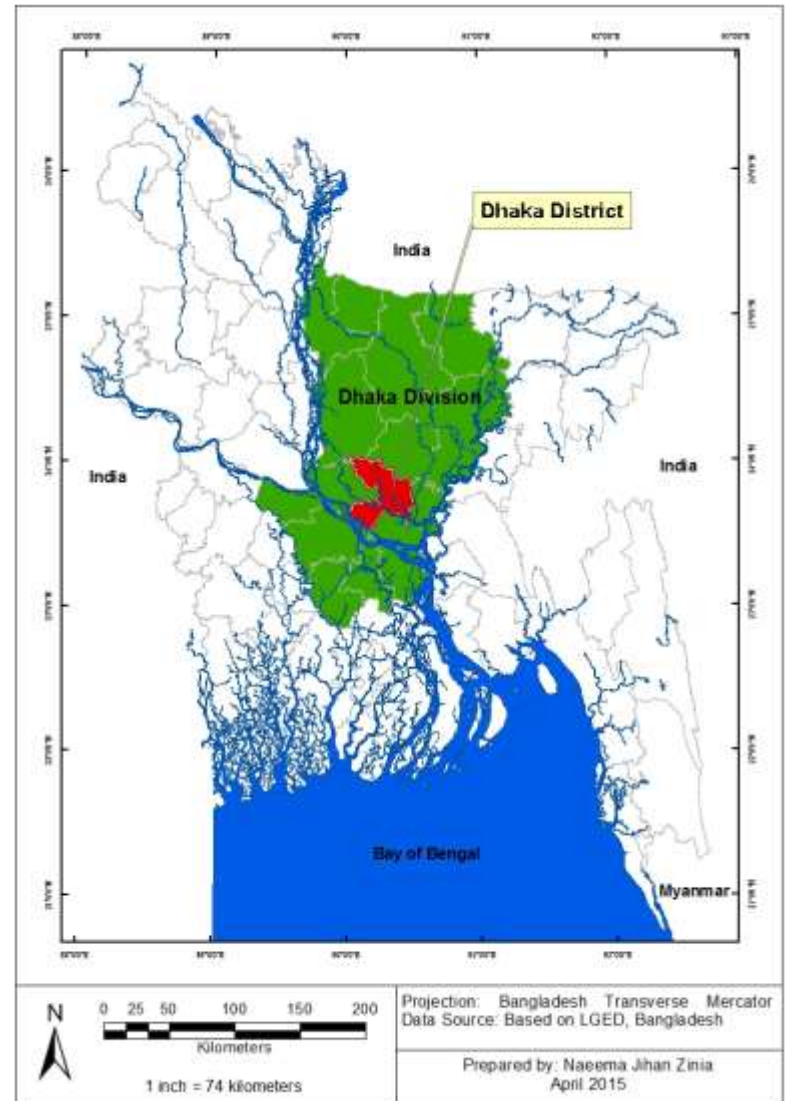
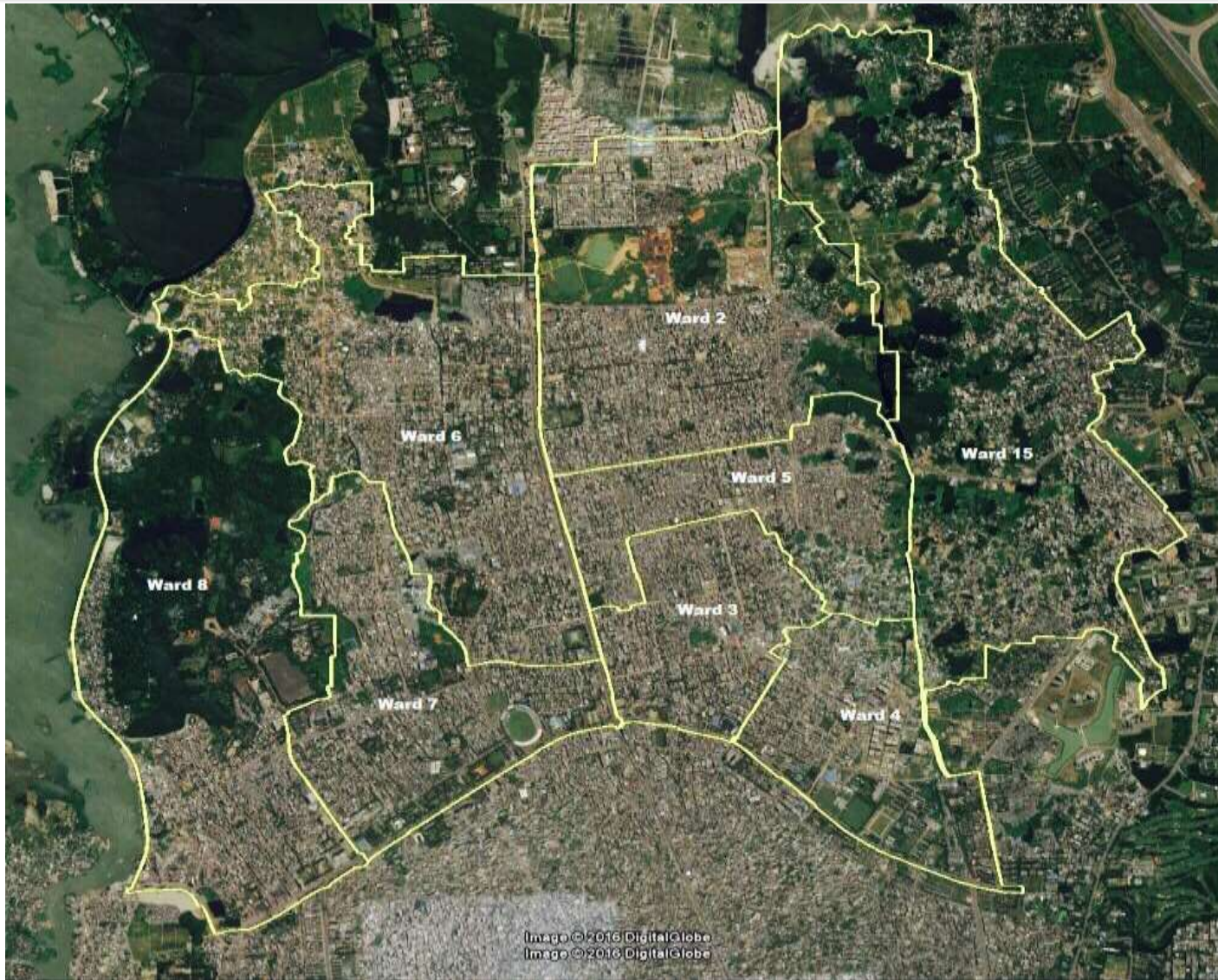# DHAKA: A HIGHLY BUILT UP CITY

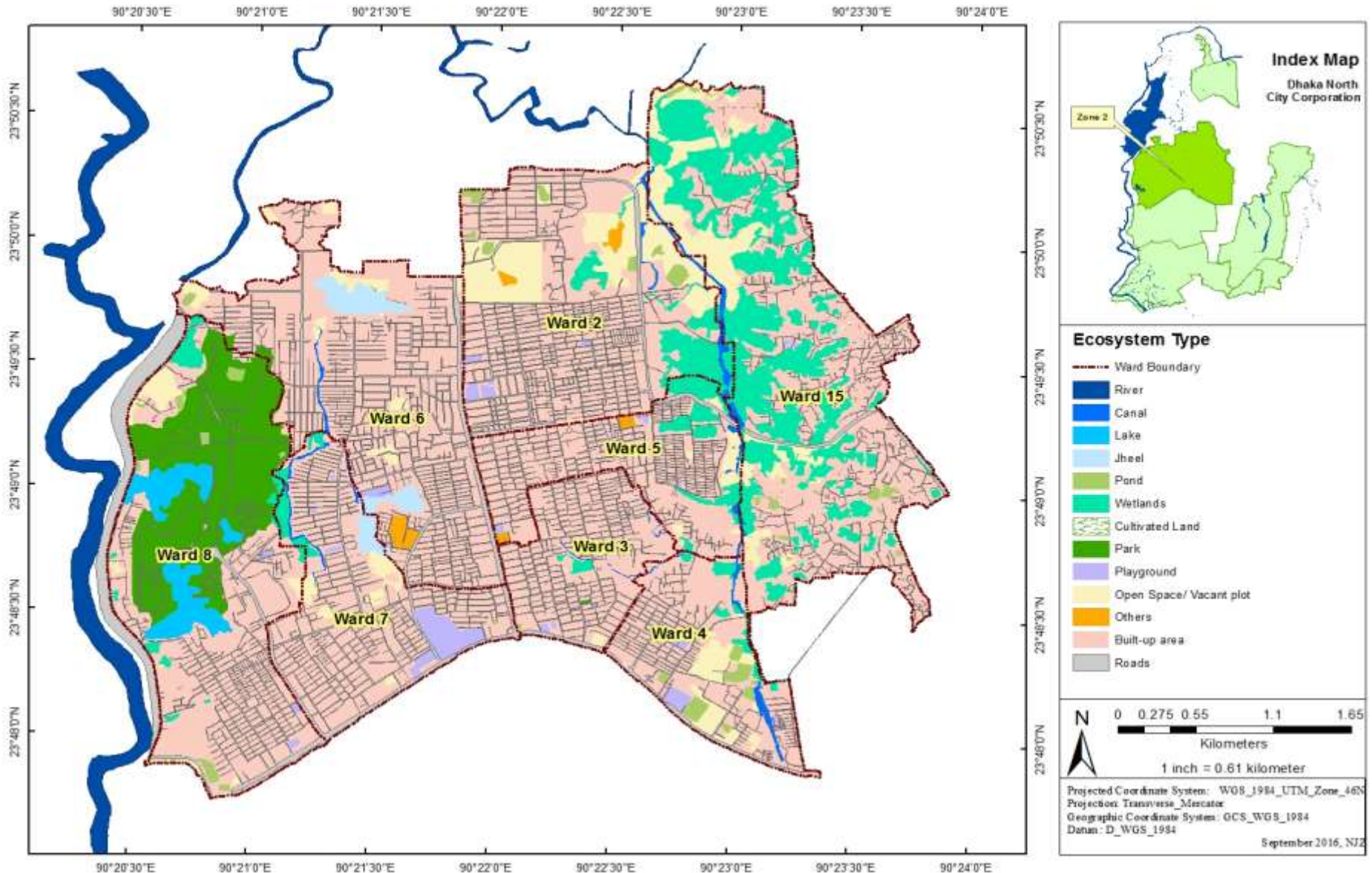# DHAKA: URBAN BLUE SPACES

OBJECTIVE

Contribute to <u>urban ecosystem services management</u> in Dhaka by recommending economically feasible and socially acceptable <u>green adaptation strategies</u>.

MONASH University

INVENTORY OF ECOSYSTEM SERVICES

Ecosystem Services (ES)		Urban Ecosystems										
		Green spaces						Blue spaces				
		Park/garden	Roadside trees	Cultivated land	Playground	Open space/ vacant plot	Graveyards	Pond	Jheel	Lake	Khal	Wetland
Provisioning ES	Crops, Fruits, Vegetables	x		x					x			x
	Fish							x	x	x		x
	Water supply							x	x		x	x
	Fodder								x		x	x
	Medicinal plants	x										
	Fuel wood	x	x		x	x	x					
	Timber	x	x	x	x	x	x					
Regulating ES	Capturing Particulate matter (PM)	x	x	x	x	x	x					
	Carbon sequestration	x	x	x	x	x	x					
	Microclimate regulation	x	x	x	x	x	x	x	x	x	x	x
	Drainage							x	x	x	x	x
	Flood prevention	x	x	x	x	x		x	x	x	x	x
	Strom protection	x	x		x		x	x	x	x	x	x
	Noise abatement	x			x	x	x		x		x	x
	Water purification	x										
Cultural ES	Opportunities for recreation	x	x		x				x		x	
	Cognitive development- Research and education	x										
	Aesthetic information	x								x	x	
	Inspiration for culture and art	x			x			x	x			x
	Religious use				x							
Supporting ES	Nursery service and refugia for resident and migratory birds	x	x			x	x	x	x	x	x	x
	Gene pool/biodiversity protection	x	x			x	x	x	x	x	x	x

14

Valuation of the produces (fruits and vegetables) from rooftop gardens in the study area
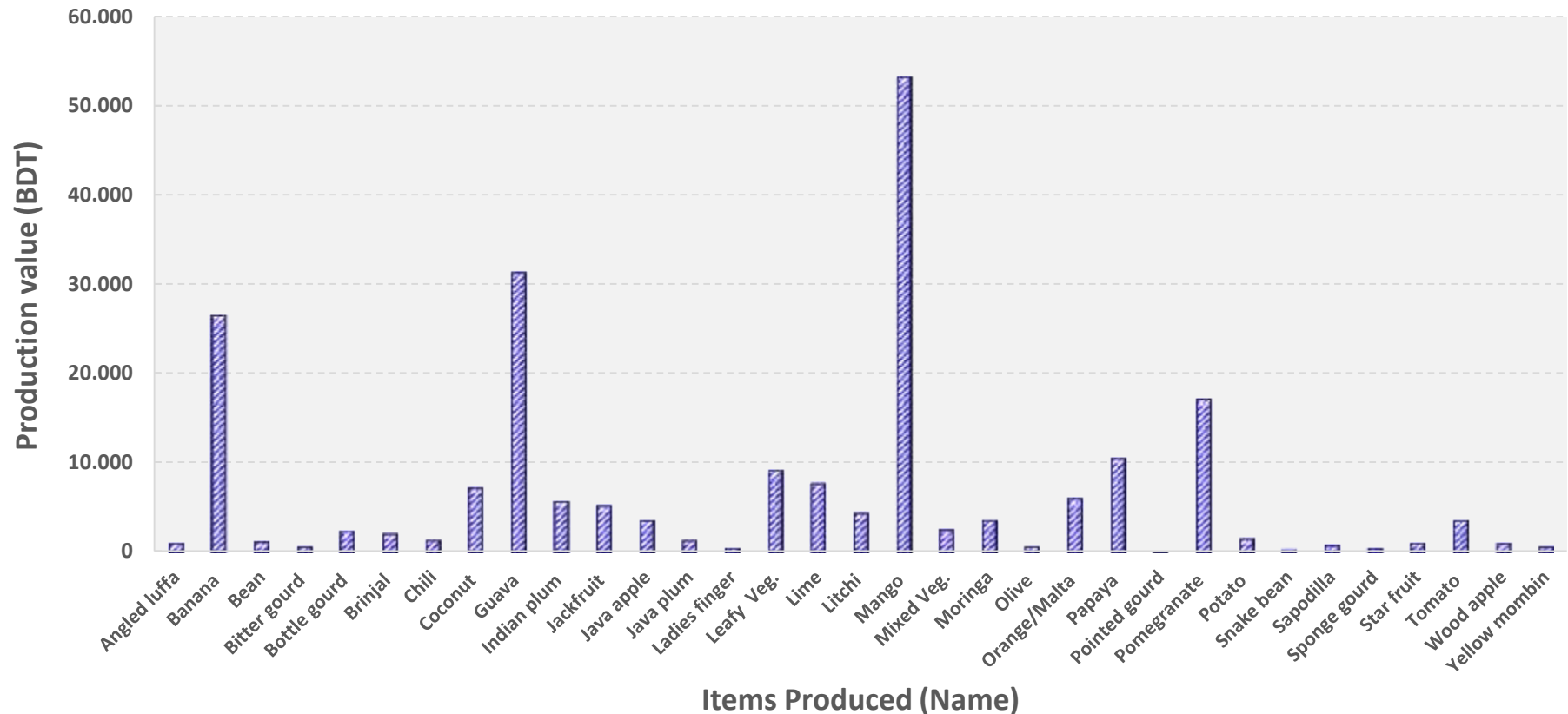
SELECTED REGULATING SERVICES

- ❏ **Climate regulation-** Carbon sequestration/ Carbon stock

- ❏ **Influence on air quality-** Particulate Matters (PM) capture

TREE MEASUREMENT

Number of trees measured in the park
10 sub-plots (20 x 20 meter)

Sub-plot no.	Number of trees			Sub-plot total trees (no.)
	Mature trees (DBH > 20 cm)	Poles (DBH 10- 20 cm)	Saplings (DBH <10 cm)	
1	44	17	12	73
2	59	16	0	75
3	60	35	39	134
4	41	8	8	57
5	36	16	4	56
6	20	55	28	103
7	64	11	4	79
8	38	15	15	68
9	25	12	13	50
10	37	16	10	63
Total	424	201	133	758

MONASH University

Number of measured roadside trees
13 sub-plots (30 x 30 meter)

Road name	Sub-plot no.	Number of trees			Sub-plot total trees (no.)
		Mature trees (DBH > 20 cm)	Poles (DBH 10-20 cm)	Saplings (DBH <10 cm)	
Zoo road	1	7	5	4	16
	2	10	18	4	32
	3	11	3	0	14
	4	20	5	0	25
Mirpur road	1	11	3	17	31
	2	10	4	15	29
	3	8	14	29	51
	4	10	6	25	41
Begum Rokeya Swaroni	1	0	9	4	13
	2	7	5	18	30
	3	4	2	6	12
	4	9	0	0	9
	5	1	1	3	5
Total	**13**	**108**	**75**	**125**	**308**

MONASH University

VALUATION OF REGULATING SERVICES

Carbon Stock: Quantity

$$\ln(AGB) = -2.289 + 2.649\ln(DBH) - 0.021\ln(DBH)^2$$

AGB= Above Ground Biomass (kg)
DBH= Diameter at Breast Height (cm)
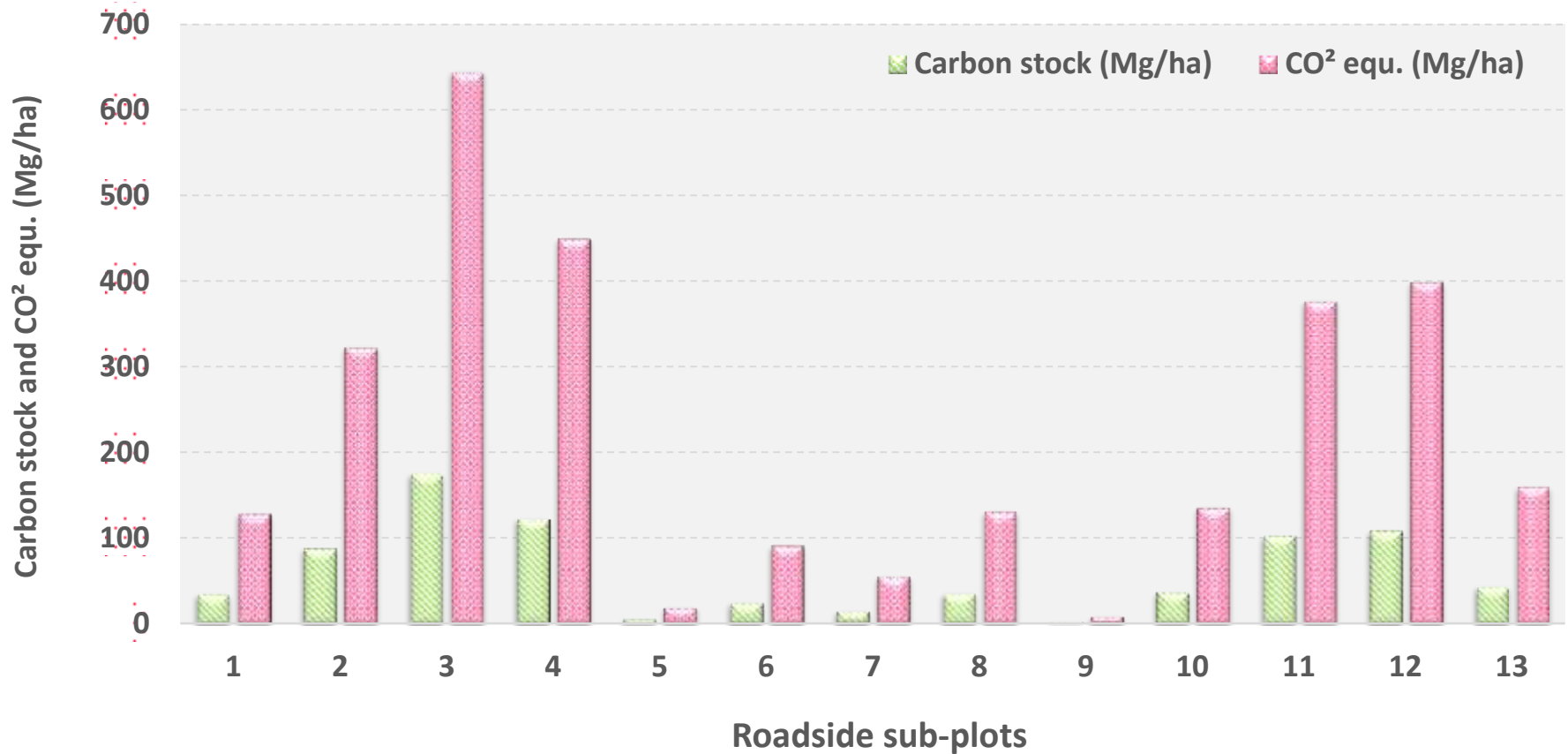
Source: Pearson et al (2005) and Yuen et al (2016)

$$Carbon\ Stock = AGB \times 0.47$$

$$CO2\ equivalent = AGB \times 0.47 \times 3.67$$

Source: Alamgir et al (2016)

MONASH
University
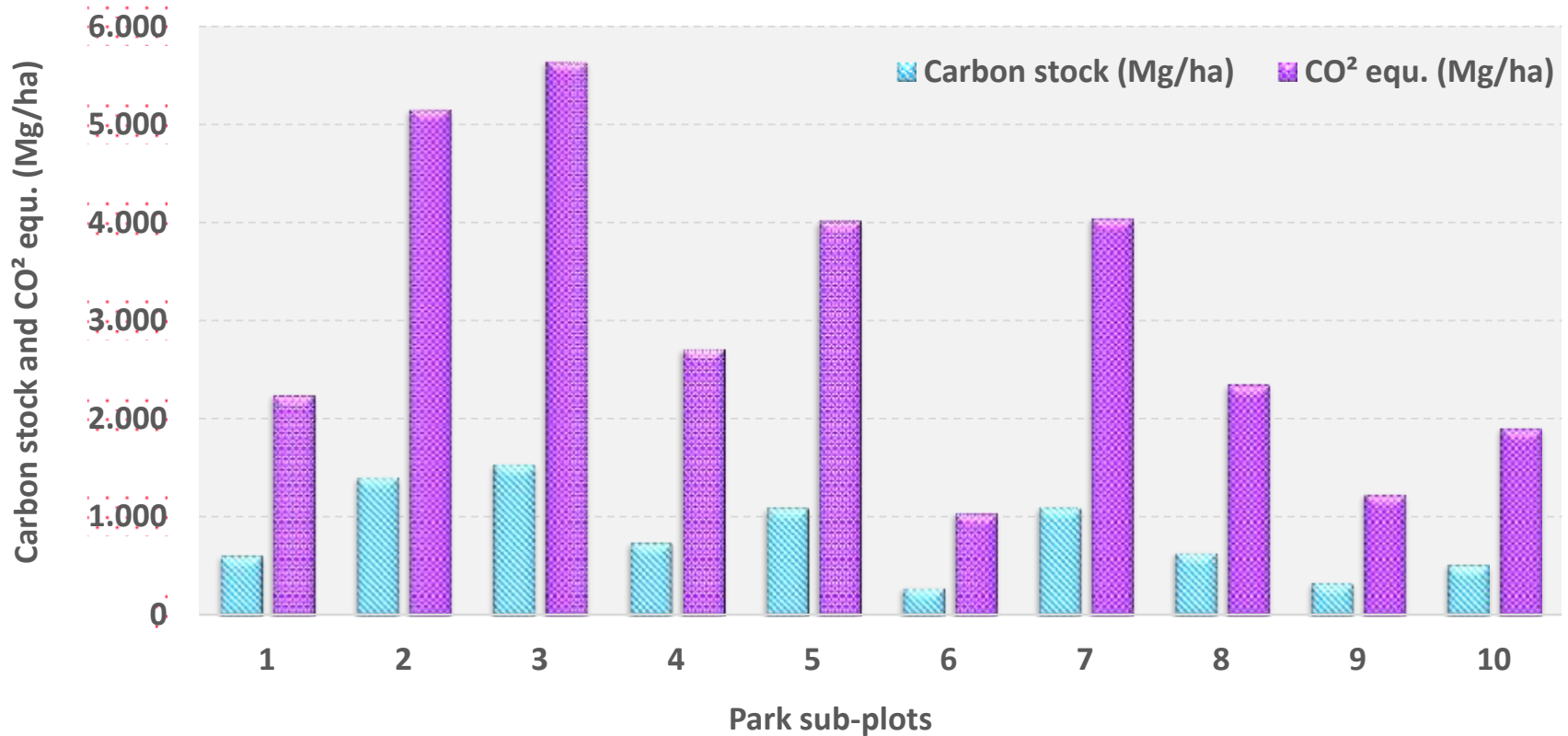
Total carbon stock and CO2 equ. in the roadside tree of the sub-plots are 798.2 Mg/ha and 2929.3 Mg/ha, respectively.

Total carbon stock and CO2 equ. in the park trees of the sub-plots are 8283.6 Mg/ha and 30401.0 Mg/ha, respectively.

Carbon Stock: Price

Country	Carbon price (USD/Mg of CO2 equ)	Carbon price (BDT/Mg of CO2 equ)
Sweden	150	11,700
Finland	23	1,794

Carbon Stock: Value (Year 2016)

Ecosystems	Swedish price	Finland price
	Value of CO2 equ (USD/ha/year)	Value of CO2 equ (USD/ha/year)
Roadside tree sub-plot total	439,388.5	67,372.9
Roadside tree sub-plot Average	29,880.0	4,581.6
Park tree sub-plot total	4,560,143.6	699,222.0
Park tree sub-plot Average	456,014.4	69,922.2

PM Capture: Price

Method	Abatement Cost (BDT/ha)	Abatement Cost (USD/ha)
Dry sweeping	816,418	10,467
Wet sweeping	3,167,401	40,608

Source: Rahman et al (2016)

PM Capture: Quantity

$$Pollutant\ Capture = Pollutant\ Flux \times Area \times Time$$

$$Pollutant\ Flux = Deposition\ Velocity \times Concentration\ of\ air\ pollutant$$

Units:
Pollutant Capture (g/sec)
Pollutant Flux (g/cm2/sec)
Area i.e. tree cover (cm2)
Time period (sec)
Deposition Velocity (cm/sec)
Concentration of air pollutant (g/cm3)

Sources:
Lovett, 1994
Nowak, 1994
Jim and Chen, 2008

MONASH University

30

PM_{10} Capture: Quantity

PM_{10} capture or removal (Mg/year) by trees in the study area

Range	Total removal quantity (Mg/year)	
	Roadside trees	Park trees
Average	7.4	22.1
Max	9.6	29.6
Min	10.6	34.2

PM_{10} Capture: Value (Year 2016)

PM_{10} abatement cost saved by trees in the study area

PM_{10} capture Value (mill USD/ha/year) (Dry sweeping)		PM_{10} capture Value (mill USD/ha/year) (Wet sweeping)		Range
Roadside trees	Park trees	Roadside trees	Park trees	
0.08	0.23	0.30	0.90	Average
0.10	0.31	0.39	1.20	Max
0.11	0.36	0.43	1.39	Min

MONASH University

KEY MESSAGES

- ❑ Ecosystems in urban areas play crucial roles in regulating ecological functions, supporting primary production, creating food provision and non-material benefits.

- ❑ Apart from aesthetics, other benefits are often overlooked as prices are not attached to them.

MONASH University

- ❑ The surveyed rooftop gardens produce USD ~3,500 year^{-1} worth fruits and vegetables in the study area.

- ❑ The estimated values for CO_2 equivalent storage are on average USD ~70,000 ha^{-1} year^{-1} by park and USD ~4,500 ha^{-1} year^{-1} by roadside trees.

- ❑ The average PM_{10} abatement cost saved by the park range between USD 0.23-0.90 million ha^{-1} year^{-1}.

❑Valuation is important!

❑This study will motivate citizens and policy makers for sustainable urban ecosystem management in Dhaka and similar cities.

THANK YOU

How to quantify

❑ <u>cooling effects</u> generated by ecosystems?

❑ <u>drainage services</u> provided by waterbodies?