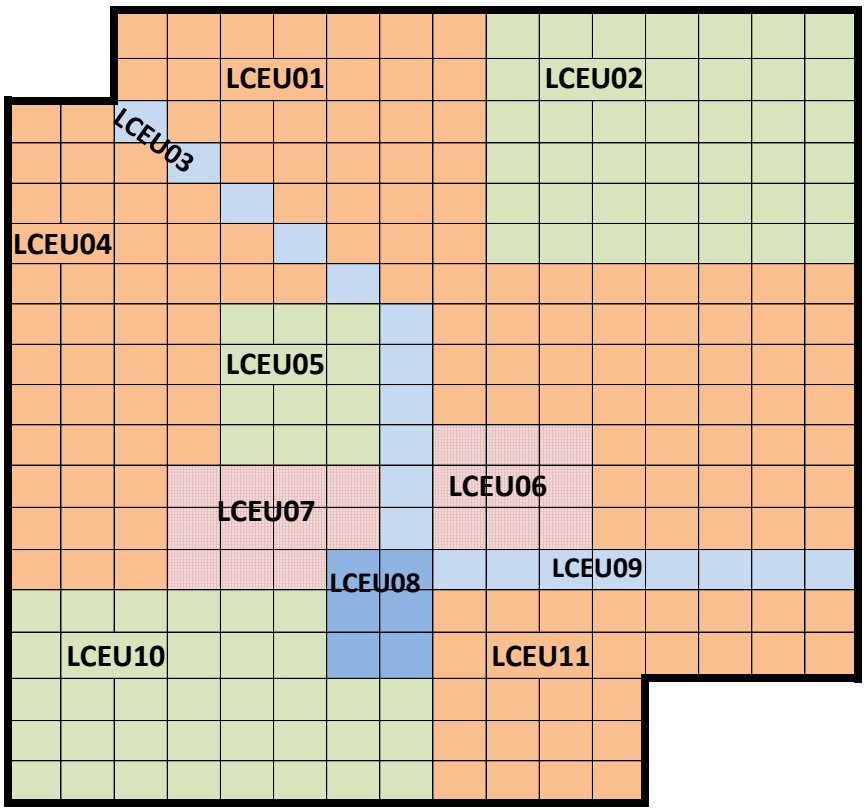
Spatial Units: Group Exercise 1: Calculate area of each LCEU and LCEU type



Note: One BSU = 250m*250m = 6.25 ha

EAU area = 288 BSUs = 18 km^2

1 ha = (100m x 100m) = 10,000m^2

1 km^2 = 100 ha = 1,000,000m^2

LCEU Table

LCEU	BSU count	Area (km^2)
LCEU01 = Rainfed herbaceous cropland		
LCEU02 = Forest tree cover		
LCEU03 = Inland water bodies		
LCEU04 = Rainfed herbaceous cropland		
LCEU05 = Forest tree cover		
LCEU06 = Urban and associated developed		
LCEU07 = Urban and associated developed		
LCEU08 = Open wetlands		
LCEU09 = Inland water bodies		
LCEU10 = Forest tree cover		
LCEU11 = Rainfed herbaceous cropland		
Total		

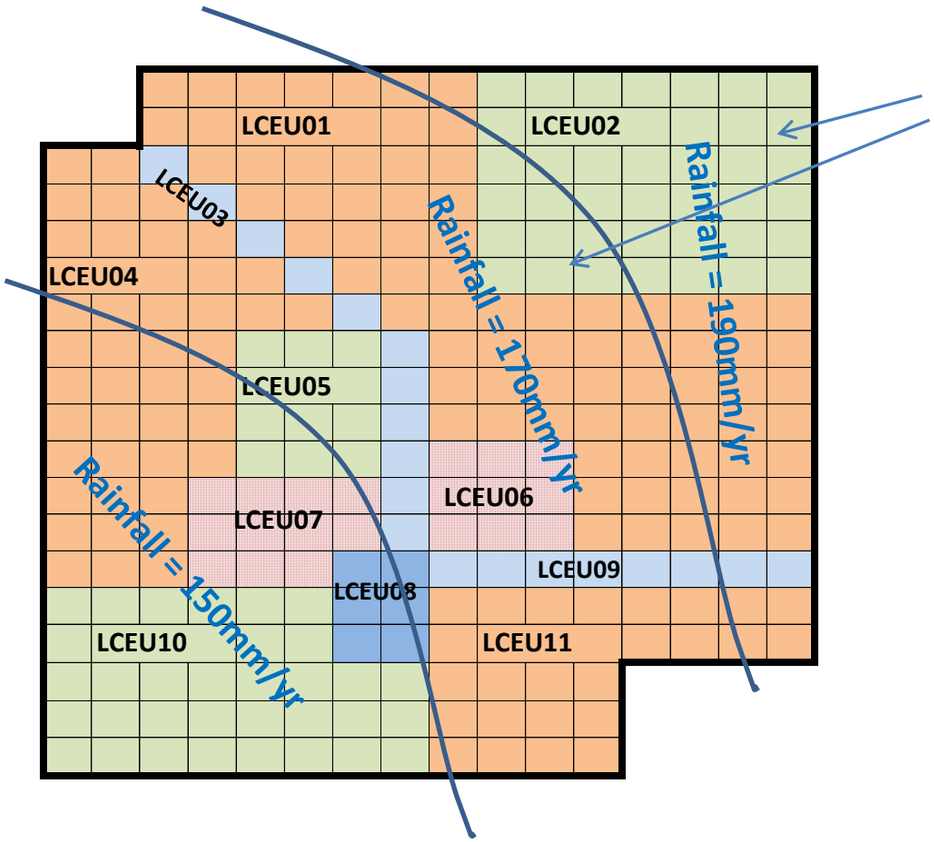
Summary Table

LCEU Type	BSU count	Area (km^2)
Urban and associated		
Rainfed herbaceous cropland		
Forest tree cover		
Inland water bodies		
Open wetlands		
Total		

Note: 1 Km ^{2} = BSU count / 16

Instructions: (1) Count the BSUs in each LCEU and record in the BSU Count column of the LCEU Table.
(2) Calculate the area for each LCEU
(3) Add the BSU Count and Area for each LCEU type and record in the Summary Table

Spatial Units: Group Exercise2: Calculate average rainfall (mm/year) for each LCEU



Rainfall table

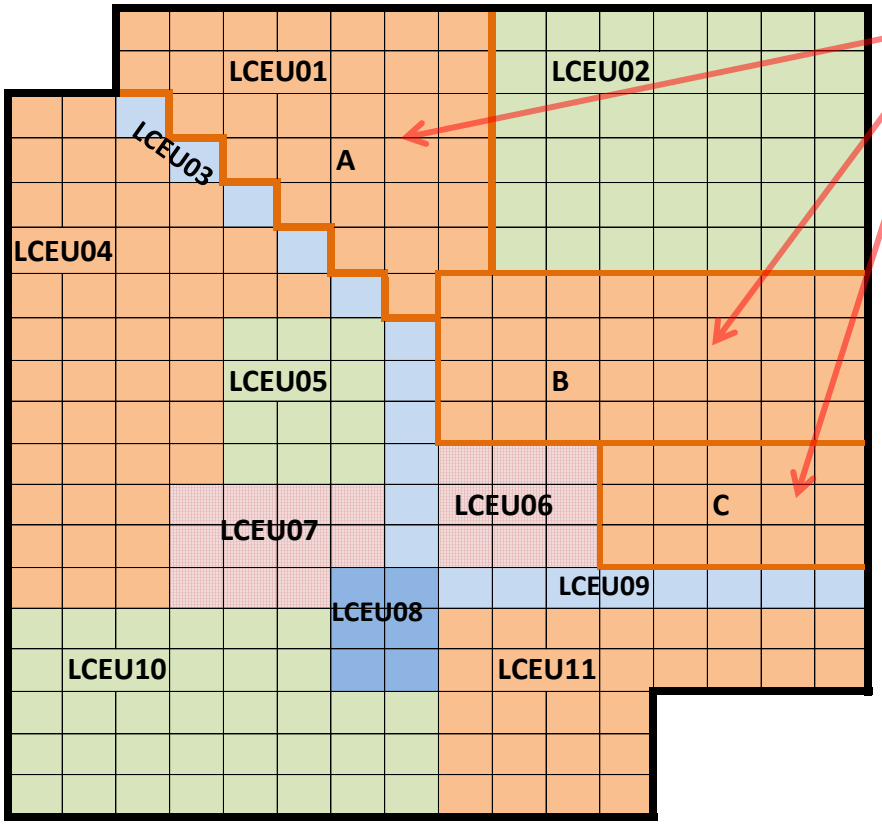
LCEU02	BSU Count	Total rainfall (mm)	
A: Rainfall = 190mm/yr			=BSU*190
B: Rainfall = 170mm/yr			=BSU*170
Total			= A + B

Rainfall summary table

	BSU Count	Average rainfall (mm)	
LCEU02 average Rainfall			=(A+B)/(BSU Count)

Instuctions: (1) For LCEU02 only, count the number of BSU in each rainfall band. Record in the BSU Count column of the Rainfall Table. Count partial BSUs as well.
(2) Calculate the Total rainfall
(3) Calculate the Total BSU Count for LCEU02.
(4) Calculate the Average rainfall for LCEU02 (Total rainfall/total BSU count)

Spatial Units: Group Exercise3: Calculate average production (Tonnes/ha) for LCEU01



Farm productivity

Farm	Production (tonnes)	BSU Count	Productivity (tonnes/ha)	
A	6,500			=Production / BSU / 16
B	9,000			=Production / BSU / 16
C	3,200			=Production / BSU / 16

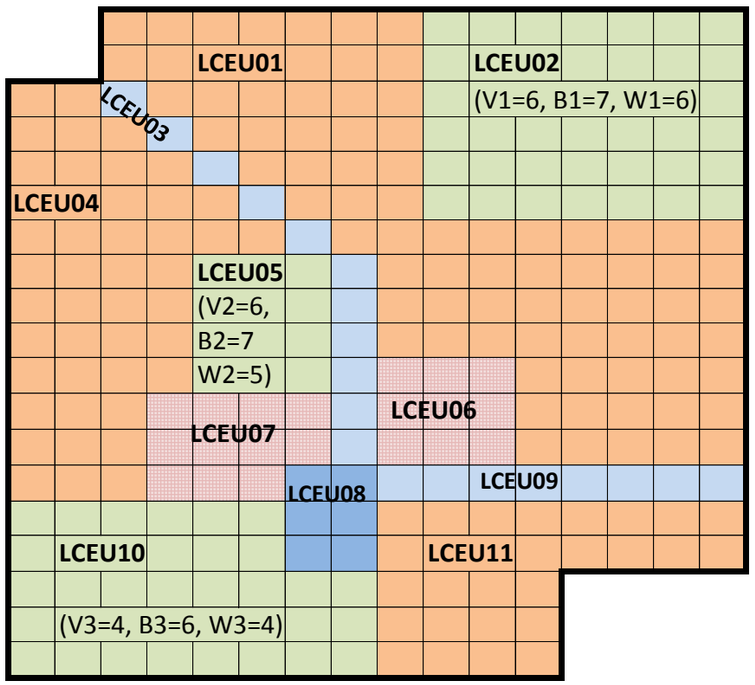
LCEU01 Productivity

	Total Production	BSU Count	Average Productivity	
LCEU01				=Production / BSU / 16

Instructions: (1) Count the number of BSUs in each farm (A, B, and C). Record the results in the BSU Count column.
(2) Calculate the Productivity of each farm (A, B, and C). Record in the result in the Productivity column.
(3) Calculate the Total Production for LCEU02. Calculate the Total BSU Count for LCEU02.
(4) Calculate the Average Productivity for LCEU02.

Condition Account: Group Exercise 1: Calculate improvements and reductions in condition

(Opening Conditions)



Condition Table

LCEU	Extent (BSU)	(V) Vegetation	(B) Biodiversity	(W) Water	Index	
LCEU01 = Rainfed herbaceous cropland	80	4.00	3.00	5.00	4.00	
LCEU02 = Forest tree cover	42					=(V+B+W)/3
LCEU03 = Inland water bodies	11	5.00	6.00	6.00	5.67	
LCEU04 = Rainfed herbaceous cropland	45	3.00	2.00	4.00	3.00	
LCEU05 = Forest tree cover	12					=(V+B+W)/3
LCEU06 = Urban and associated developed	9	2.00	2.00	4.00	2.67	
LCEU07 = Urban and associated developed	11	2.00	1.00	3.00	2.00	
LCEU08 = Open wetlands	6	5.00	7.00	5.00	5.67	
LCEU09 = Inland water bodies	8	3.00	3.00	4.00	3.33	
LCEU10 = Forest tree cover	36					=(V+B+W)/3
LCEU11 = Rainfed herbaceous cropland	28	3.00	2.00	3.00	2.67	
	288					

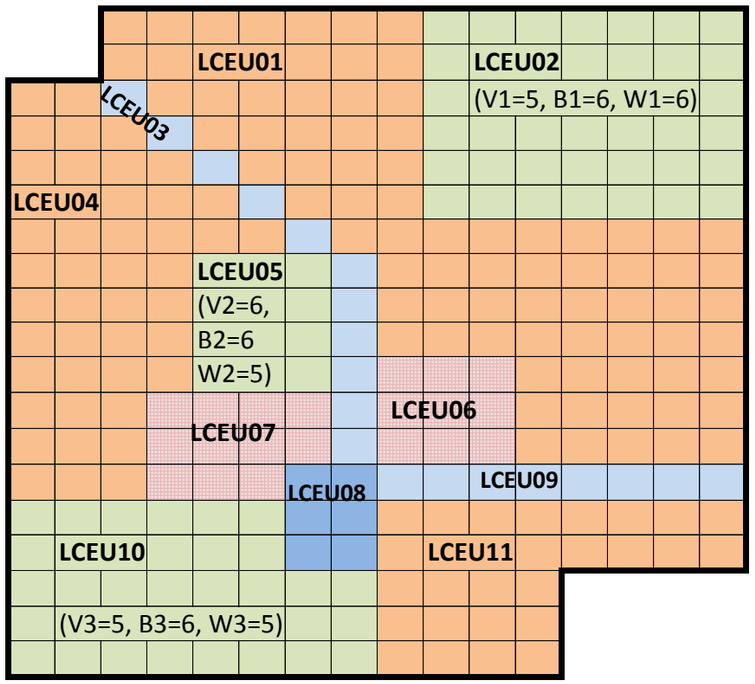
LCEU Type	Extent (BSU)	Vegetation	Biodiversity	Water	Index	
Urban and associated	20	2.00	1.45	3.45	2.30	
Rainfed herbaceous cropland	153	3.52	2.52	4.34	3.46	
Forest tree cover	90					=(V+B+W)/3
Inland water bodies	19	4.16	4.74	5.16	4.68	
Open wetlands	6	5.00	7.00	5.00	5.67	
Total	**288**	**4.01**	**3.96**	4.57	4.18	

Note: (A) is components prorated by area

Instructions: (1) Transfer the condition measures from the map to the Condition Table for LCEU02, LCEU05 and LCEU10.
(2) Calculate the Index (V+B+W)/3
(3) Calculate the pro-rated condition measure for Forest Tree Cover (multiply measure * BSU Count for each area; add and divide by total BSU Count). Calculate the index.

Condition Account: Group Exercise 1: Calculate improvements and reductions in condition

(Closing Conditions)



Condition Table

LCEU	Extent (BSU)	Vegetation	Biodiversity	Water	Index
LCEU01 = Rainfed herbaceous cropland	80	4.00	3.00	6.00	4.33
LCEU02 = Forest tree cover	42	5.00	6.00	6.00	5.67
LCEU03 = Inland water bodies	11	5.00	6.00	7.00	6.00
LCEU04 = Rainfed herbaceous cropland	45	3.00	3.00	5.00	3.67
LCEU05 = Forest tree cover	12	6.00	6.00	5.00	5.67
LCEU06 = Urban and associated developed	9	2.00	2.00	4.00	2.67
LCEU07 = Urban and associated developed	11	2.00	1.00	3.00	2.00
LCEU08 = Open wetlands	6	5.00	7.00	6.00	6.00
LCEU09 = Inland water bodies	8	3.00	3.00	5.00	3.67
LCEU10 = Forest tree cover	36	5.00	6.00	5.00	5.33
LCEU11 = Rainfed herbaceous cropland	28	3.00	3.00	4.00	3.33
	288				

LCEU Type	Extent (BSU)	Vegetation	Biodiversity	Water	Index
Urban and associated	20	2.00	1.45	3.45	2.30
Rainfed herbaceous cropland	153	3.52	3.00	5.34	3.95
Forest tree cover	90	5.13	6.00	5.47	5.53
Inland water bodies	19	4.16	4.74	6.16	5.02
Open wetlands	6	5.00	7.00	6.00	6.00
Total	**288**	**3.99**	**4.03**	5.32	4.45

Note: (A) is components prorated by area

Condition Account

	Extent (BSU)	Vegetation	Biodiversity	Water	Index
Opening Conditions	288				
Improvements in condition					
Reductions in condition					
Closing Conditions	288	3.99	4.03	5.32	4.45

Instructions: (1) Transfer the values for Opening and Closing Conditions to the appropriate row of the Condition Account.
(2) Calculate difference between Opening and Closing Conditions (Closing - Opening)
(3) Record Improvements (positive values) in the Improvements row
(4) Record reductions (negative values) in the Reductions row

Land Accounting: Step 1 - Calculate Opening and Closing Land Cover (hectares)

Opening Land Cover

M	M	M	M	M	S	G	G	S	S
G	M	M	S	S	S	G	S	S	S
T	G	S	G	G	G	G	S	S	S
T	G	A	A	G	G	S	T	T	T
T	G	A	A	A	A	T	T	T	T
T	T	T	A	A	A	C	C	C	T
E	T	A	P	P	A	A	C	C	T
S	S	A	P	P	P	C	C	T	T
S	A	A	P	R	R	R	G	T	T
S	S	A	R	R	R	R	T	T	T

Note: Each cell represents one hectare.

Opening Land Cover		Code	Count (ha)
Artificial surfaces		**A**	
Crops		**C**	
Grassland		**G**	
Tree covered area		**T**	
Mangroves		**M**	
Shrub covered area		**S**	
Regularly flooded areas		**R**	
Sparse natural vegetated areas		**P**	
Terrestrial barren land		**E**	
Permanent snow, glaciers and inland water bodies		**X**	
Total			**100**

Closing Land Cover

P	M	M	M	M	S	G	G	S	S
G	M	M	S	S	S	G	S	S	S
C	G	S	G	G	G	G	C	C	S
C	C	A	A	G	G	S	C	C	T
C	G	A	A	A	A	C	C	C	T
T	T	T	A	A	A	C	C	C	T
E	T	A	A	A	A	A	C	C	T
S	S	A	A	P	P	C	C	T	T
S	A	A	P	R	R	R	G	T	T
S	S	A	R	R	R	R	T	T	T

Note: Each cell represents one hectare.

Closing Land Cover		Code	Count (ha)
Artificial surfaces		**A**	
Crops		**C**	
Grassland		**G**	
Tree covered area		**T**	
Mangroves		**M**	
Shrub covered area		**S**	
Regularly flooded areas		**R**	
Sparse natural vegetated areas		**P**	
Terrestrial barren land		**E**	
Permanent snow, glaciers and inland water bodies		**X**	
Total			**100**

Instructions: Count the number of cells (hectares) for each land cover type and record in the Land Cover table.

Land Accounting: Step 2 - Calculate Land Cover Change Matrix and Physical Account for Land Cover

Table 1: Net Land Cover Change Matrix (hectares)

		Closing Land Cover										
		Artificial surfaces	Crops	Grassland	Tree covered area	Mangroves	Shrub covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	**Opening**
Opening Land Cover	Code	**A**	**C**	**G**	**T**	**M**	**S**	**R**	**P**	**E**	**X**	
Artificial surfaces	**A**											
Crops	**C**											
Grassland	**G**											
Tree covered area	**T**											
Mangroves	**M**											
Shrub covered area	**S**											
Regularly flooded areas	**R**											
Sparse natural vegetated areas	**P**											
Terrestrial barren land	**E**											
Permanent snow, glaciers and inland water bodies	**X**											
Closing												

Note: Rows represent reductions in stock; columns represent deletions in stock

Instructions: (1) Transfer the Opening and Closing areas from the Land Cover Tables.
(2) Count areas with no change and record on the diagonal.
(3) Record changes from Opening to Closing in rows (e.g., 1ha grassland changed to Crop)
(4) Check: Rows add to Opening; Columns add to Closing.

Table 2: Physical Account for Land Cover

	Artificial surfaces	Crops	Grassland	Tree covered area	Mangroves	Shrub covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	**Total**
Opening Stock											
Additions to Stock											
Reductions in Stock											
Closing Stock											

Note: Reductions are sum of row, excluding areas that remained the same

Instructions: (1) Transfer Opening Land Cover to Opening Stock row

(2) Transfer Closing Land Cover to Closing Stock row

(3) Add columns (excluding areas that stayed the same) to obtain Additions to Stock

(4) Add rows (excluding areas that stayed the same) to obtain Reductions in Stock

(5) Check: Total Stock = 100; Additions = Reductions

Carbon Accounting: Step 3 - Calculate Carbon Stock Account and Carbon Sequestration Services

Carbon Accounting: Step 1 - Calculate Opening and Closing Land Cover (hectares)

Opening Land Cover

M	M	M	M	M	S	G	G	S	S
G	M	M	S	S	S	G	S	S	S
T	G	S	G	G	G	G	S	S	S
T	G	A	A	G	G	S	T	T	T
T	G	A	A	A	A	T	T	T	T
T	T	T	A	A	A	C	C	C	T
E	T	A	P	P	A	A	C	C	T
S	S	A	P	P	P	C	C	T	T
S	A	A	P	R	R	R	G	T	T
S	S	A	R	R	R	R	T	T	T

Note: Each cell represents one hectare.

Opening Land Cover		Code	Count (ha)
Artificial surfaces		**A**	
Crops		**C**	
Grassland		**G**	
Tree covered area		**T**	
Mangroves		**M**	
Shrub covered area		**S**	
Regularly flooded areas		**R**	
Sparse natural vegetated areas		**P**	
Terrestrial barren land		**E**	
Permanent snow, glaciers and inland water bodies		**X**	
Total			**100**

Closing Land Cover

P	M	M	M	M	S	G	G	S	S
G	M	M	S	S	S	G	S	S	S
C	G	S	G	G	G	G	C	C	S
C	C	A	A	G	G	S	C	C	T
C	G	A	A	A	A	C	C	C	T
T	T	T	A	A	A	C	C	C	T
E	T	A	A	A	A	A	C	C	T
S	S	A	A	P	P	C	C	T	T
S	A	A	P	R	R	R	G	T	T
S	S	A	R	R	R	R	T	T	T

Note: Each cell represents one hectare.

Closing Land Cover		Code	Count (ha)
Artificial surfaces		**A**	
Crops		**C**	
Grassland		**G**	
Tree covered area		**T**	
Mangroves		**M**	
Shrub covered area		**S**	
Regularly flooded areas		**R**	
Sparse natural vegetated areas		**P**	
Terrestrial barren land		**E**	
Permanent snow, glaciers and inland water bodies		**X**	
Total			**100**

Instructions: Count the number of cells (hectares) for each land cover type and record in the Land Cover table.

Carbon Accounting: Step 2 - Calculate Land Cover Change Matrix and Physical Account for Land Cover

Table 1: Net Land Cover Change Matrix (hectares)

		Closing Land Cover										
		Artificial surfaces	Crops	Grassland	Tree covered area	Mangroves	Shrub covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	**Opening**
Opening Land Cover	Code	**A**	**C**	**G**	**T**	**M**	**S**	**R**	**P**	**E**	**X**	
Artificial surfaces	**A**											
Crops	**C**											
Grassland	**G**											
Tree covered area	**T**											
Mangroves	**M**											
Shrub covered area	**S**											
Regularly flooded areas	**R**											
Sparse natural vegetated areas	**P**											
Terrestrial barren land	**E**											
Permanent snow, glaciers and inland water bodies	**X**											
Closing												

Note: Rows represent reductions in stock; columns represent deletions in stock

Instructions: (1) Transfer the Opening and Closing areas from the Land Cover Tables.
(2) Count areas with no change and record on the diagonal.
(3) Record changes from Opening to Closing in rows (e.g., 1ha grassland changed to Crop)
(4) Check: Rows add to Opening; Columns add to Closing.

Table 2: Physical Account for Land Cover

	Artificial surfaces	Crops	Grassland	Tree covered area	Mangroves	Shrub covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	**Total**
Opening Stock											
Additions to Stock											
Reductions in Stock											
Closing Stock											

Note: Reductions are sum of row, excluding areas that remained the same

Instructions: (1) Transfer Opening Land Cover to Opening Stock row
(2) Transfer Closing Land Cover to Closing Stock row
(3) Add columns (excluding areas that stayed the same) to obtain Additions to Stock
(4) Add rows (excluding areas that stayed the same) to obtain Reductions in Stock
(5) Check: Total Stock = 100; Additions = Reductions
Carbon Accounting: Step 3 - Calculate Carbon Stock Account and Carbon Sequestration Services

Table 4: Simplified Carbon Stock Account

	Artificial surfaces	Crops	Grassland	Tree covered area	Mangroves	Shrub covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	**Total**
Carbon Stored (tonnes/ha)	5	40	10	200	800	80	300	8	0	0	
Carbon Stock (tonnes)											
Opening											
Increases											
Decreases											
Net change											
Closing											

Note: Opening is Opening Land area * Carbon Stored

Net change is Increases - Decreases

Instructions: (1) Multiply each value in the Physical Account for Land Cover by the corresponding value for Carbon Stored.

Table 5: Account of Ecosystem Services from Carbon Sequestration (tonnes/year)

	Artificial surfaces	Crops	Grassland	Tree covered area	Mangroves	Shrub covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	glaciers and inland water bodies	**Total**
Carbon Sequestration (tonnes/ha/year)	0	20	2	30	100	5	40	1	0	0	
Carbon Sequestration (tonnes/year)											
Opening: Carbon Sequestration											
Closing: Carbon Sequestration											
Net change											

Note: Opening is Opening land area * Carbon Sequestration

Instructions: (1) Multiply each value in the Physical Account for Land Cover by the corresponding value for Carbon Sequestration.

Services Generation Account: Group Exercise 1

Services Generation Database

LCEU	Extent (ha)	(C) Crop tonnes/year	(R) Recreation trips/year	(W) Water m^3/year	(S) Carbon Sequestration tonnes /ha/year	(S) Carbon Sequestration tonnes /year
LCEU01 = Rainfed herbaceous cropland	500.0	18,700.0	500.0	600.0	20	
LCEU02 = Forest tree cover	262.5	0.0	1,500.0	500.0	30	
LCEU03 = Inland water bodies	68.8	0.0	1,600.0	15,000.0	5	
LCEU04 = Rainfed herbaceous cropland	281.3				20	
LCEU05 = Forest tree cover	75.0				30	
LCEU06 = Urban and associated developed	56.3	0.0	500.0	500.0	0	
LCEU07 = Urban and associated developed	68.8	0.0	700.0	400.0	0	
LCEU08 = Open wetlands	37.5	700.0	5,000.0	10,000.0	40	
LCEU09 = Inland water bodies	50.0				5	
LCEU10 = Forest tree cover	225.0				30	
LCEU11 = Rainfed herbaceous cropland	175.0				20	
Total	**1,800.0**					

Instructions: (1) Calculate unknown services from nearest neighbour for (C), (R), W); e.g., Crop for LCEU04 = LCEU01/500*281
(2) Carbon, calculate from lookup table (S); e.g., Carbon for LCEU01 = 20*500)
(3) Calculate EAU Total for each service