### National Land Cover Data (CadasterENV) for Urban mapping and Monitoring MUAS, 4 November 2015

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- 1. CadasterENV Sweden
- 2. Mapping method, process and challenges
- 3. User examples





## CadasterENV Sweden

- National mapping
- Funded by ESA (DUE)
- Nov 2012- Oct/Nov 2015
- Swedish Users





Statistiska centralbyrån Statistics Sweden





of Agriculture



Länsstyrelsen Västerbotten



LANTMÄTERIET

esa







## CadasterENV Sweden

#### Develop and implement a system for:

- Map LC in two different scales
- Detect and monitoring changes
- According to the Swedish users requirements

#### Scale levels:

- 10 meters resolution to map LC and identify changes at a national level (HR)
- **2 meters** resolution with focus on LC and changes within urban areas for local and regional planning (VHR)





# Input data today ... onwards



= increased opportunities to obtain cloud-free scenes





## **General user needs**

- Homogeneous and nationwide land cover data
- A possibility to update LC data on a regular basis
- Reasonable production costs on a national level
- INSPIRE compatible







## Thematic LC core need

 The land cover shall be mapped but not valued (map what you see regardless of the context of the area, e.g. map buildings and artificial surfaces but don't categorize them as spares or dense urban areas)









## **User requirements**

Identifier	Description	User	Prio
	URBAN		
RB-1	The actual land cover shall be mapped (regardless of whether it is inside of urban areas or not).	SCB	1
RB-2	The same land cover classes shall be used for vegetated areas within urban areas as well as outside.	SCB,SBA, CAB, Lantm, SEPA	1
RB-3	Impervious surfaces shall be mapped similarly regardless of whether they are within or outside urban boundaries.	SCB	1
RB-4	Impervious areas shall be separated in built-up and non- built up areas	SCB, CAB	1
RB-5	The definition of sparse and dense urban structure from SMD shall be used	SCB	1
RB-6	Mapping should not be based on existing urban boundaries.	SCB	1
RB-7	Extractions and dump areas.	SEPA, SCB	2
RB-8	Golf courses		2
RB-9	Morphology (structure) of buildings	SCB, CAB	1
RB-10	Height of buildings	SCB, CAB	1
RB-11	Update frequency 5 years	SCB, SEPA	

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	whether it is inside of urban areas or not).		
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RB-3	Impervious surfaces shall be mapped similarly regardless of	sca	1
00.4	whether they are within or outside urban boundaries.	550 SAD	
P.11-11	built up areas	aca, coa	•
RB-S	The definition of sparse and dense urban structure from SMD shall be used	SCR	1
RB-6	Mapping should not be based on existing urban boundaries.	SCB	1
RB-7	Extractions and dump areas.	SEPA, SCB	2
RB-S	Golf courses		2
RB-9	Morphology (structure) of buildings	SCB, CAB	1
RB-10	Height of buildings	SCB, CAB	1
RB-11	Update frequency 5 years	SCB, SEPA	
R8-100	Forest classes from KNAS	CAB. SEPA	1
RB-101	Forest definitions shall be adapted to FAO	SCB, SBA, CAB, Lantm,	1
		SEPA	
RH-102	Non-productive forests shall be classified according to forest type	CAB, SEPA	2
RB-103	Refine age groups	CAB	1
RB-104	An improved delineation of forest on wetlands	CAB, SEPA	1
RB-105	Field layers, especially lichen-rich shall be mapped	CAB, SEPA	2
RB-106	Field layers with heath vegetation, herb and grass are also	CAB	2
	of interest to map.		
RB-107	Burnt forest areas shall be distinguished from clearings	CAB	2
RB-108	Storm-felled forest areas to be distinguished from	CAB	2
RB-109	Other disturbed forest due to scree and flooding to be	CAB	2
	distinguished from clearings		
RB-110 RB-111	Differentiate exotic species within spruce and pine forests Specify type of deciduous forest (e.e. aspen and willow)	CAB	2
	within the class Mixed forest. Find and classify deciduous		1
	torest within the coniferous forest also when the deciduous forest doesn't reach 30% of the crown cover.		1
RB-112	Find older forests on sand / gravel / ridge (N2000 9060)	CAB	2
RB-113	Find nutritious spruce and non-nutritious pine on sand	CAB	2
RB-114	Land elevation forests are of interest to map	CAB	+
RB-115	Update frequency 5-10 years	SEPA	
00.116	epinete - equality 3-44 years		I.
ra-110	rne swedish definition of non-productive forest shall be followed	SEPA, CAB	1
	AGRICULTURAL AREAS		
RB-200	Open agricultural areas shall be distinguished from wooded	SBA, CAB, SEPA	1
	agricultural lands		
RB-201	Definition of wooded pastures shall be based on FAO (> 10%)	SBA, CAB, SEPA	1
RB-202	Coverage of 5-10% shall be mapped as "Other wooded	SEPA,	1
	land" according to FAO		
KH-204	Identify wooded agricultural land of high conservational value	CAB, SEPA	1
RB-204	Grasslands outside LPIS shall be separated from other	SBA, CAB, SEPA	2
	subgroups of "other open land".		
RH-205	Distinguish permanent leys from temporary leys	SBA	2
RB-206	Constructed wetlands	SBA	2
RB-207	Map larger landscape elements as attributes	SBA, SEPA	2
RB-208	Update frequency of agricultural land should be 3 years	SBA	1
RB-209	Store information on nature values as an attribute		2
RB-210	Encroachment of shrubs/trees. The signal from the "Change	SCB, SBA, CAB, Lantm, SEPA	1
	Alert" shall be stored as an attribute.		
R8-211	(Land Parcel Identification System)	584	1
RB-212	Use LPIS for better delineation	SEPA	2
RB-213	Arable land outside LPIS shall be mapped	SBA	1
RB-214	Define wooded pastures and shrublands in accordance to	SBA	2
	the Swedish Board of Agriculture's directive SJVFS 2011-7		L
	WETLANDS		
RB-300	Improved delineation for wetlands, both between open wetland and open pop-wetland and between forested	SCB, CAB, Lantm, SEPA	1
	wetland and forested non-wetland.		
RB-301	Trees/bushes on wetlands shall be mapped	SCB, CAB, Lantm, SEPA	1
RB-302	Traditionally managed wetlands	SEPA	1
RB-303	Incorporate VMI (when digitized)	CAB, SEPA	1
RB-304	Classify according to hydro-topographic units bog, fen,	CAB	1
	mixed mire.		
nai-405	classing according to field layer (grass, moss etc)	CAR	2
	WATER		
RB-400	Fresh water shall be distinguished from oceans	SCB, CAB, Lantm, SEPA	1
RB-401	Distinguish different types of lakes	CAB	2
RB-402	Read (10 m width)	CAB, SEPA	1 .
			<b>^</b>
RB-403	Lower water vegetation ( water lilies, pondweed etc)	CAB	2
RB-403	Lower water vegetation ( water lilles, pondweed etc) OTHER	CAB	2
RB-403 RB-500	Lower water vegetation ( water lilies, pondweed etc) OTHER Substrate areas and heathland	CAB CAB, SEPA, SBA	2
RB-403 RB-500 RB-501	Lower water vegetation ( water liles, pondweed etc) OTHER Subtrate areas and heathland Sand environments	CAB CAB, SEPA, SBA CAB	2 2 2
RB-403 RB-500 RB-501 RB-502	Conservation (water Illes, pondweed etc) OTHER Substrate areas and heathland Sand environments Power line corridors	CAB CAB, SEPA, SBA CAB CAB	2 2 2 2
RB-403 RB-500 RB-501 RB-502 RB-503	Lease User Materia Contract Services (Material Material Materiae Material Material Materiae Materiae Materiae Materiae M	CAB CAB, SEPA, SBA CAB CAB CAB	2 2 2 2 2 2
RB-403 RB-500 RB-501 RB-502 RB-502 RB-504	Inter ten human Concern water vegetation ( water like, pondweed etc) COLER Substrate areas and heathland Substrate areas	CAB CAB, SEPA, SBA CAB CAB CAB CAB	2 2 2 2 2 2 2
RB-500 RB-501 RB-502 RB-503 RB-504	Losser water vegetation ( water likes, pondweed etc) OTHE Solution and the solution of the solution of the solution Sand evolutionments Power line corridoms with grass Accuracy of each close for different parts of the country	CAB CAB, SEPA, SBA CAB CAB CAB CAB CAB	2 2 2 2 1
RB-403 RB-500 RB-501 RB-502 RB-503 RB-504 RB-505	Lower water vegetation ( water liter, pondwered etc.) OTHE Substrate areas and Realiboand Sund enversamments Power lites certains Power	САВ САВ, SEPA, SBA САВ САВ САВ САВ САВ SEPA	2 2 2 2 2 1 1 1
RB-403 RB-500 RB-501 RB-502 RB-503 RB-504 RB-505 RB-506	Low water vegatation ( water like, pondwared etc) ONE Subtrate areas and heatbland Suid andronometic Power line contribunt Power line contribunt Power line contribunt Power line contribunt Accuracy of each class for different parts of the country Compatibility herease Classiare classification registres, Classification and DAAS.	САВ САВ, SEPA, SBA САВ САВ САВ САВ SEPA САВ SEPA САВ	2 2 2 2 2 1 1 2 2
RB-403 RB-500 RB-501 RB-502 RB-503 RB-504 RB-505 RB-506	Lover water vegetation ( water liter, ponduered etc.) COTEE Substrate areas and Reatiband Sand enversements Power lites corridors with grass Power lites corridors with grass Accuracy of each clock for difference parts of the country Corporations interprete Calculater classification system, CLC accuracy clock of the field have (grass, herb, head have). CEC	САВ САВ, SEPA, SBA САВ САВ САВ SEPA САВ	2 2 2 2 1 1 2 2
RB-403 RB-500 RB-501 RB-502 RB-503 RB-504 RB-505 RB-506 RB-600	Conservation optimization (variant lines, poindwared etc.) OTHE Subtracts areas and hearthband Subdracts areas and hearthband Power lines controlons, White grass. Accuracy of each class for different parts of the sountry Comparising hearthbanes. Classifier classifier classifier classifier and RMA. Classify according to field layev (grass, hesh, headh head) IDE Dire yourly politicate data (e.g. UPIS) can be used for a	CAB 52694, 58A CAB 52694, 58A CAB 52694, 58A CAB 52694 CAB 526944 CAB 52694 CAB 526944 52694764 52694767647676767676767676767676767767767677767777	2 2 2 2 2 1 1 1 2 2 1 1 1 1 1 1 1 1 1 1
RB-403 RB-500 RB-501 RB-502 RB-503 RB-506 RB-506 RB-500	Clover water vegetation ( water liter, ponduced etc) CTUE Substrate areas and heatbland Substrate areas and heatbland Weaver liter certains Power liter cert	CAB CAB, SEPA, SBA CAB CAB CAB SEPA CAB CAB, SEPA CAB, SEPA	2 2 2 2 2 1 1 1 2 2 1 2 1 1 2 2 1 2 1 2
RB-403 RB-500 RB-501 RB-502 RB-503 RB-504 RB-505 RB-506 RB-600 RB-601	Course water registration ( water likes, poindweed etc.) <b>OTHE</b> Subtrate areas and healthand Suid areasoningst. Power line corridon Power line corridon Power line corridon Power line corridon Compatibility thereases. Classian classification system, CLC Coursel according to field layer (grass, herb, headh eig) COMP you'ry opidated data (e.g. LPR) can be used for a you'ry opidated of the LC.	CA8 CA0, SEPA, S0A CA8 CA8 CA8 CA8 SEPA CA8 CA8 CA8 CA8 CA8 CA8 CA8 CA8 CA8 CA	2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
RB-403 RB-500 RB-501 RB-502 RB-503 RB-504 RB-505 RB-505 RB-600 RB-601 RB-602	Coner water vegetation ( water liter, ponduered etc) CTUE Substrate areas and floatMand Substrat	CA8 CA8, SEPA, SBA CA8 CA8 CA8 CA8 CA8 CA8 CA8 CA8 CA8 CA	2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
RB-500 RB-501 RB-501 RB-503 RB-503 RB-504 RB-505 RB-506 RB-600 RB-601 RB-602 RB-602	Course water registration ( water line, poindwared etc) <b>CPUE</b> Subtrate areas and heathband Sund anreasments Power line contains with grass Power line contains and grass the country Course's according to field tayer (grass, herb, herab etc) CO Directly according to field tayer (grass, herb, herab etc) CO Directly according to field tayer (grass, herb, herab etc) CO Directly according to field tayer (grass, herb, herb, herb) CO Directly according to field tayer (grass, herb, herb) Course according to tragen Charge streamer main class grasps	CAB CAD, SEPA, SBA CAB CAB CAB CAB CAB CAB CAB CAB CAB, SEPA CAB, SEPA CAB, SEPA	2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1
RB-403 RB-500 RB-501 RB-502 RB-503 RB-504 RB-504 RB-506 RB-601 RB-601 RB-602 RB-604	Lover water vegetation ( water liter, pondwered etc) CTUE Subtrate areas and flexibilities Subtrate	CAB CAB, SEPA, SBA CAB CAB CAB CAB SEPA CAB CAB, SEPA CAB, SEPA SCE, SBA, CAB, Lauton, SEPA SGE, SBA, CAB, Lauton, SEPA	2 2 2 2 2 2 1 1 1 1 1 1 1 2 1 1 1 2 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
RB-403 RB-500 RB-501 RB-501 RB-503 RB-504 RB-505 RB-505 RB-600 RB-601 RB-601 RB-603 RB-603 RB-604	Conservator agricultation ( substrilline, poindoweed etc.) CTUE CONSERVATION CONSTRUCTION ( Substrilline, poindoweed etc.) Substritus areas and healthouts Substritus areas and healthouts Power line contrilors with grass Power line controls with grass Control substritution ( Substritution system, CCC 2007 yearly updated coll Power and when the public lever (grass, here), head with a Power line activity in public lever (Grass, here), head with a Power and when the update here ( Const her decided from Phages of builty record (grass) in 1955 areas) Phages of distlicity cover (grass) in 1955 areas) Phages of distlicity and wettand	CAB CAB, SEPA, SBA CAB CAB CAB CAB CAB CAB CAB CAB CAB C	2 2 2 2 2 2 1 1 1 1 1 1 2 1 1 1 1 1 1 1
R8-403 R8-500 R8-501 R8-503 R8-503 R8-504 R8-505 R8-505 R8-601 R8-601 R8-601 R8-603 R8-604 R8-605	Coder water eigenstation ( water litter, piondusered etc.) CTUEN Subtrate areas and Institution Power litter correlation Coder and Institution Coder And Instituti	CAB CAB, SEPA, SBA CAB CAB CAB CAB SEPA CAB CAB SEPA CAB, SEPA SEB, SBA, CAB, Laotton, SEPA SEB, SBA, CAB, Laotton, SEPA	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
R8-403 R8-501 R8-501 R8-503 R8-503 R8-505 R8-601 R8-601 R8-601 R8-601 R8-603 R8-604 R8	Cancer water registration ( water line, posndawed etc) <b>CPUED</b> Contracts and Anabhand Sand enveronments Power line contracts Power line	САВ САВ, 550%, 58А САВ САВ САВ САВ САВ САВ САВ САВ, 550% САВ, 550	2 2 2 2 2 2 1 1 1 2 1 1 1 1 1 1 1 1 2 1 1 2 1 1 2 1 1 2 1 1 2 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
RB-403 RB-500 RB-501 RB-503 RB-503 RB-504 RB-505 RB-506 RB-601 RB-601 RB-601 RB-604 RB-605 RB-605 RB-605 RB-605	Coder water experiation ( water liker, pondueed etc) CTUE Subtrate areas and flexibilities Subtrate areas and flexibilities Subtrate areas and flexibilities Subtrate areas and flexibilities Prover the correlation with great Accuracy of adapt flexibilities Comparison of the subtrate of the construction Comparison of the flexibilities Comparison of the construction Comparison of the flexibilities Comparison of the construction Comp	CAB CAB, 569A, 58A CAB CAB CAB CAB SEPA CAB CAB CAB, 56PA CAB, 56PA SEB CAB, 56PA SEB SEB CAB, CAB, Lantin, SEPA SEB SEA SEA SEA SEA SEA SEA SEA SEA SEA SEA	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 2 1 1 2 1 1 2 1 1 2 1 1 2 1 2 2 2 2 2 2 2 2 2 2 2 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
R8-403 R8-500 R8-501 R8-503 R8-503 R8-505 R8-506 R8-506 R8-600 R8-601 R8-603 R8-604 R8-604 R8-605 R8-606 R8-607 R8-608	Claser water organization ( water line, pondowed etc) <b>CDEW</b> Calculation and Machibani Substrate areas and Substrate areas and Substrate Substrate areas and Substrate areas and Substrate Substrate areas and Substrate areas and Substrate areas Substrate areas areas areas Substrate areas areas areas areas areas areas areas areas	CAB CAB, 507A, 58A CAB CAB CAB CAB CAB CAB CAB CAB CAB, 557A CAB SIFA, CAB, Lantin, SIFA CAB SIFA, CAB CAB	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 2 2 1 1 1 2 2 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
RB-403 RB-500 RB-501 RB-503 RB-504 RB-505 RB-505 RB-505 RB-505 RB-600 RB-601 RB-602 RB-603 RB-603 RB-605 RB-605 RB-605 RB-605 RB-605 RB-605 RB-605	Coder water experiation ( water liker, ponduered etc)  CDER  Subtrate areas and heatbland Prover like control of the subtrate of the subtr	САВ САВ, 5024, 504 САВ, 5024, 504 САВ САВ САВ 5557A САВ, 557A САВ, 557A САВ, 557A 555, 554, САВ, 140111, 557A 566 567A 567A 567A 567A 567A 567A 5	2 2 2 2 2 2 1 1 1 2 2 2 2 2 2 1 1 1 1 2 1 1 1 2 1 1 1 2 2 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2



# **LC Deliverables**

- 24 thematic classes
  - Level 1-3
  - HR/VHR
  - Raster 2/10 m
- Attributes as separate layers
  - Land use
  - Object height
    - 0,5-5 m
    - >5 m
  - Object cover
    - 0,5-5 m
    - ⊳ >5 m
  - Forest Productivity
  - Age









#### Legend

2 Open wetland 3 Arable land 41 Non-vegetated other open land 42 Vegetated other open land 51 Built-up areas 52 Non built-up areas 61 Inland waters 62 Marine water 111 Pine forest (not on wetlands) 112 Spruce forest (not on wetlands) 113 Mixed coniferous forest (not on wetlands) 114 Mixed forest (not on wetlands) 115 Deciduous forest (not on wetlands) 116 Deciduous hardwood forest (not on wetlands) 117 Deciduous forest with hardwood forest (not on wetlands) 118 Disturbed forest (not on wetland) /////, Forest on wetlands













## Toolbox



### **Toolbox**



cadasterenv

**H**H



2014









### **Vector to raster conversion**

Statistical correct and/or visually appealing...



Centroid



Maximum area



cadasterenv sweden



### Imperviousness (percentage)

Buildings

Roads

10x10 meter



# Green vs impervious: mixels -> vegetation?



Strengthening of vegetation content in mixed pixels





## **User Examples**

THIR COULDER

-----

See.

## How green are our cities?

- Cities > 30 000 citizens
- Follow the result of planning policy (eg densification)
- Indicators of human health, living environment and quality of life (nationally and internationally)
- Basis for analyzing climate change and climate adaptation
- Basis for the quantification of ecosystem services

Stefan Svanström & Jerker Moström Statistics Sweden



Källa: Bearbetningar © SCB, övriga geodata © Lantmäteriet

### Mapped all urban areas > 30 000 citizens







© Statistics Sweden and Lantmäteriet

For questions and further information, please contact:

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metria

## Repeatability

- Every 5th year!
  - Based on 10 meter satellite data, height information and ancillary map data
  - Cloud free data, time for registration
  - Sentinel-2
- Changes
  - Arable land
  - Exploitations
  - Water new/ disappeared/water vegetation







Stockholm County in 2030, Regional Development Plan, Stockholm County Council

### The Challenge

In Stockholm County we need to build over 20 000 new homes per year and provide all the connecting infrastructure in a long-term sustainable way

... without increasing fragmentation (for animals and plants)

.... and keep and increase the ecosystem services

### We need to plan for a functional Green infrastructure

Klara Tullback & Helle Skånes Stockholm County , SU

# Documented need for a county wide and detailed biotope database





- **High resolution biotope data** is needed within nature conservation and urban planning for:
  - Contextual **planning** and sustainable city development
  - Modelling potential species distribution and ecosystem services
  - Protection/management/monitoring of green spaces
- Current biotope database, is done by conventional air photo interpretation.
  - The need is to cover the entire county (potentially beyond).
  - Conventional method (air photo interpret. only) is not efficient
- We should combine several techniques: map data, satellite, LiDAR. etc. classifications **and** visual air photo interpretation!
- The aim is to create:
  - A robust method for an improved coherent, spatially complete biotope database covering large areas in a cost efficient way
  - Not the most detailed biotope database ever!

Ortofoto © Lantmäteriet i2014/00691

#### Spatial resolution matters - Swedish land cover data (national) SMD



Aggregated for comparison and readability

#### **Spatial resolution matters - Stockholm's current biotope database**



Aggregated for comparison and readability

#### **Spatial resolution matters - New prototype biotope database** (county - country) with CadasterENV



Aggregated for comparison and readability

Gardens and urban green structure

## Continuation

The objective is a homogenous, nationwide LC mapping system with an effective method for updating and maintenance

- National coverage HR (10 m raster)
- VHR coverage larger cities (2 m raster)
- Update every 5<sup>th</sup> year

More information : camilla.jonsson@metria.se





