IM-Tree. Towards an information model for an integrated tree register

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Abstract

This paper gives an overview of the first steps towards a tree information model against the background of the situation in the Netherlands. Fragmented ownership and incomplete data are an obstacle for effective tree management and for quantitative evaluation. The greening ambition of Europe's Common Agricultural Policy also requires tools and datasets to check claims to subsidize small landscape elements. Tools referred to are a tree crown perimeter dataset and a method to derive a 3D model from that perimeter.
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1 Introduction

The value of trees other than their wood production capacity is getting more and more attention, both in cities and in rural areas. Research [7, 8] quantified the value of trees in New York City and Chicago at 700-1000 US$ each. This includes the potential of trees in their role as providers of ecosystem services. Examples of such services are the scavenging of particulate matter, storage of CO_2 [9] and mitigation of the Urban Heat Island effect [11].

Europe recognises this value and its policy aims at an increase in the number of trees or more commonly an increase of Green area (nature) and at the same time a decrease of agricultural areas because of a surplus in agricultural production. The European Commission decided to subsidize by 2014 the taking-out-of-production of 7% of a farmer's land. This should support the increase of biodiversity ("Greening the Common Agricultural Policy (CAP)") by means of the presence of small landscape elements (< 5 hectares) like bushes, trees and hedges [12].

For safety reasons tree owners in the Netherlands have a public responsibility, a legal "obligation to care", to keep trees vital and healthy. The objective is the reduction of the danger of falling branches or trees falling over in public space. This obligation requires tree owners to keep record of individual tree condition. However, each owner does that in a different way with regard to information content and update frequency. Another aspect of the situation: there is no obligation to report the tree condition to a central point so it is unknown which tree information is collected by the various owners.

2 Point of departure

To value trees it requires data about their presence and their properties for areas as a whole. That is, you want data about trees of different owners, both public and private organizations, even of private persons. Basically what is needed is a register, which contains all the non-forest trees, of all owners, public and private. In the Netherlands, that does not exist.

This results in the situation that for instance the municipality of Amsterdam manages 240.000 trees, whereas the number of urban trees in the municipality might well be 25% higher [4]. Including trees of other owners and forest trees, the total for Amsterdam is estimated at around 500.000 trees. Such differences and uncertainties limit the potential to effectively battle pests and diseases: the source of contaminations might be in trees of the neighbouring owner. This fragmented situation also is an obstacle for calculations regarding ecosystem service levels. Also, there is no reference for landscape elements that might qualify for the CAP subsidies.

We conclude that there is a need for an integrated register on trees, both for urban and rural areas.

3 To an integrated tree register

In the Netherlands, conditions seem favourable to experiment with combining existing tree data in an integrated manner:

- There is an interest among tree professionals for assessments like those in New York and Chicago. The i-Tree software, developed by USDA (http://www.itreetools.org/) is freely available. Unfortunately, it is adapted to the North American situation, which means that adaptation to European climate zones is necessary.
- In the period 2008-2013 the elevation has been mapped nationwide with LiDAR. From the resulting point cloud cover elevation grids were derived with a horizontal resolution of 50 cm. (http://www.ahn.nl/). One grid models the surface of the terrain including objects on top of it: the DSM. By filtering out the objects a second dataset is created that describes only the terrain surface: the DTM. From DSM and DTM spatial objects can be detected.
- Wageningen UR – Alterra researcher Clement used that data set to extract tree canopy perimeters with about 60%

completeness [10]. It is to be expected that improvement of the detection results is possible by additional use of aerial photographs and remote sensing techniques [1].

- From the Clement canopy projections, a set of tree shape parameter values can be derived, which are useful for collecting individual tree data and generate 3D visualizations [6].
- CROW, the Dutch technology platform for transport, infrastructure and public space, has started a project to standardize the tree risk assessment procedure. CROW's motivation is that there is a variety of Visual Tree Assessment methods in use. The objective of CROW is to arrive at clear inspection assignments, full exchangeability of datasets resulting from inspections with tree management software systems, a standard reference for assessment specifications. Achieving these targets should provide certainty that the assessment results can be dealt with effectively [3].
- Geonovum, the Dutch National Spatial Data Infrastructure executive committee, published the second edition of IMGeo in December 2012 [2]. IMGeo is used to build the Base Register for Large Scale Topography. It contains data specifications in the Netherlands for topographic objects from scale of 1:500 to 1:5000. This constitutes a national standard for storage and exchange of topographic objects. IMGeo contains CityGML and complies with this standard.

Current policy in the Netherlands supports strongly the close cooperation between public and private parties to create new business. This and given the conditions above led in 2012 to the set up of a Public-Private Partnership (PPP) between Wageningen UR and two private sector companies: NEO bv (remote sensing) and GEODAN bv (Geo-ICT). Its objective: to investigate the possibility for web services about tree data.

4 Tree data specifications

Because – at least in the Netherlands - there was no agreed standard for structuring data about trees, one of the tasks for 2012 of the PPP was to set up data specifications and design an Information Model for tree data. This should be an extension of the existing information model for Geometry (IMGeo). The data specifications for trees should be compliant with IMGeo containing the basic 'green' topographic objects.

The methodology used is based on experiences of the data specification process in INSPIRE also following ISO19131. In short:

- Identify use cases
- Identify requirements and spatial objects
- Analysis for completeness
- Data specification development
- Test and validate

At the time of writing the data specification development for trees is still going on.

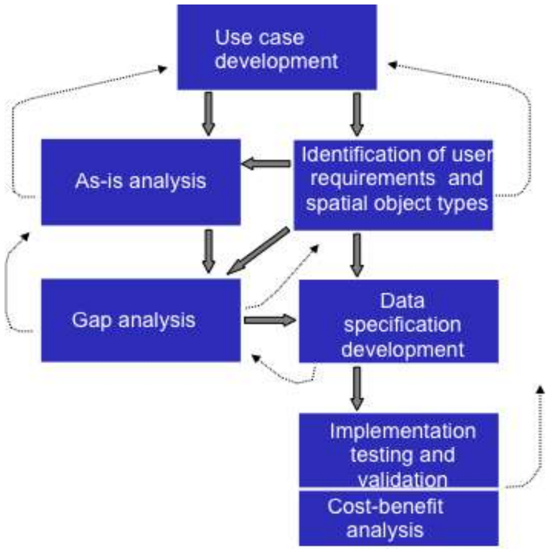

Figure 1 The INSPIRE methodology for use case development

4.1 Use cases

In order to develop the information model, a number of use cases were identified. They were used to discover what objects and properties should be included in the model. The most important cases are:

- Visual Tree Assessment / Tree Risk Assessment. Assess the health condition of individual trees to assure the safety for citizens. The stability of a tree might be influenced by diseases, storms, pests or by old age, which has to be checked regularly.
- Tree visualisation. Generate 3D scenes of tree landscapes in urban and/or rural environments for aesthetic designs and to support planning, planting and maintenance. and report about it.
- Notifications and requests. Messages sent to the tree owner about specific trees. For instance requests for cutting permits, or notifications about blown over trees, fallen branches or signs of disease. It might be a message about the presence of a pest, like the Oak Procession Caterpillar. It could also be a complaint about trees getting too high, producing too much shadow. Another cause for complaints could be the production of pollen, which can be a nuisance for persons with an allergy.
- Tree monuments. A tree can be considered meaningful and worth protection. Properties like size or age or a connection to important persons, places or occasions could be the foundation for a protective policy. This would influence maintenance decisions. Complaints about trees should be checked against its protection status.
- CAP. Establishment of landscape elements on plots of arable land to enable biotope networking, e.g. planting of hedges or copses with indigenous species. Construction of dry stone walls or planting of tree lines along field

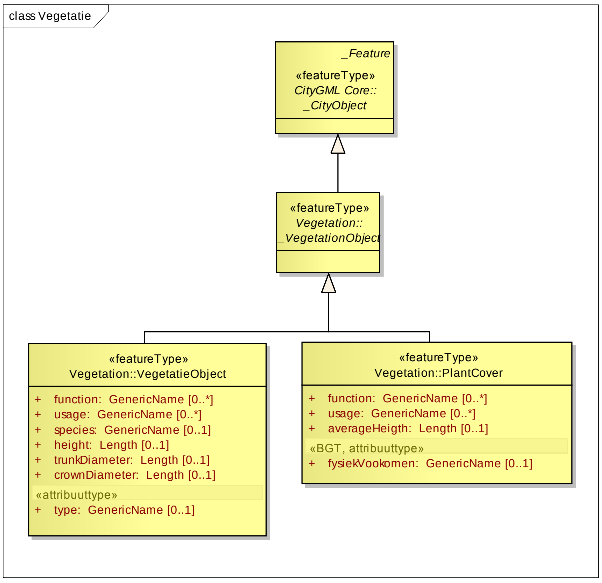

Figure 2 The SolitaryVegetationObject

borders etcetera. A farmer could receive compensation for doing this, but there are conditions to be met.

These use cases roughly cover the descriptive needs of utilitarian and aesthetic management of non-forest trees in both urban and rural settings.

4.2 Identify spatial objects

The use cases define the "Universe of Discourse" (UoD), meaning that part of the real world we are interested in. The next step is to define the spatial objects as carriers of information, being the smallest meaningful entities within the UoD. Once identified, one can specify what properties of the object are relevant. For our cases we have the tree safety properties from the tree assessment case, the tree shape properties from the visualisation case, the attributes of complaints or pest notifications and the protection status of a tree. The CAP case provides an additional perspective, being not only about individual trees, but about a combination of trees and shrubs in relation to an area of land in agricultural use.

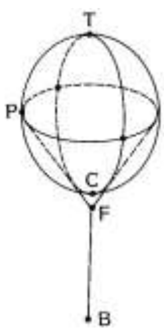

Figure 3 Silvistar 3D tree shape parameters [5]

4.3 IM-Tree

Since IMGeo and CityGML are at the base of the Tree model, the basic object is a VegetationObject defined in CityGML [13]. For an individual tree there is a subtype SolitaryVegetationObject that is extended in IMGeo as an Application Domain Extension (ADE) Element with a SolitaryVegetationObjectType property with two possible values: "Tree" and "Hedge" (fig 2).

In several use cases tree shape parameters are used to model the tree in three dimension. The forestry-based Silvistar model [5] is used for the purpose. This is different from the tree growth parameters used in SILVA [14], as it does not include the stem diameter, but has more detail on the crown perimeter shape. In short, the model uses 3-dimensional coordinates (xyz) to describe the shape of the tree (fig 3).

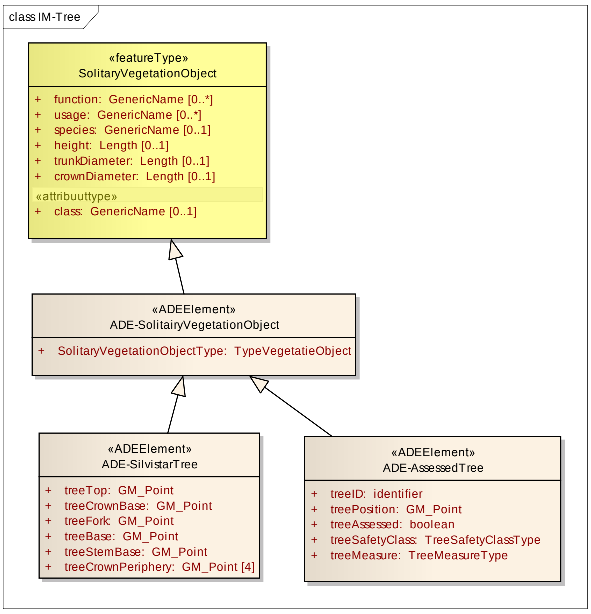

Figure 4 IM-Tree as extension of IMGeo

The Silvistar parameters are:

- Height Top (T)
- Height Crown Base (C)
- Height Fork (F)
- Height Base (B)
- Crown Periphery points (P1, P2, P3, P4)

For the Visual Tree Assessment the properties used are the following:

- Tree ID
- Tree Height (already included in IMGeo)
- Tree Position
- Tree Assessed
- Tree Safety Value
- Tree Safety Measure

Given the requirements for these two use cases only, the extension of the model can be modelled as shown in Figure 4.

5 Discussion and future work

IM-tree at this stage is merely a reconnaissance of the usefulness and need for tree data specifications. We would like to continue the specification process in close cooperation with stakeholders related to the identified use cases. We like to announce our involvement with this subject by means of this paper, mainly to start an international discussion, especially with regard to the Common Agricultural Policy. We expect that there may be other information models, and it could be fruitful to compare approaches.

References

[1] Ardila López, J.P. Object-based methods for mapping and monitoring of urban trees with multitemporal image analysis. Univ. of Twente, ITC dissertation nr.209, 2012. http://www.itc.nl/library/papers_2012/phd/ardila.pdf

[2] Brink, L. van den, H. van Eekelen, M.Reuvers. Basisregistratie Grootschalige Topografie: Gegevenscatalogus IMGeo 2.1. Geonovum, Amersfoort, December 2012 (in Dutch).

[3] Iperen, C. van. CROW start met 'Standaardisatie VTA-systematiek'. In: Groot, J.de, Congresboek Nederlandse Boominfodag 2012, Lunteren, p.50 (in Dutch).

[4] Kaljee, H. Oral communication of Amsterdam tree consultant to F.Rip at meeting in Amsterdam, Oct.15th, 2012.

[5] Koop, H. (1989). Forest Dynamics, SILVI-STAR: A Comprehensive Monitoring System. Springer, Berlin Heidelberg New York Tokyo. http://edepot.wur.nl/201980

[6] Kramer, H., J.Clement. 3D Tree Extraction from LiDAR: Trees as 3D geo objects. Presentation at the ESRI User Conference, San Diego, USA, July 2012

[7] Nowak D.J., R.E.Hoehn III, D.E.Crane, J.C.Stevens, J.T.Walton. New York City's Urban Forest. USDA Forest Service, 2007. http://www.milliontreesnyc.org/downloads/pdf/ufore_study.pdf

[8] Nowak, D.J., R.E.Hoehn III, D.E.Crane, J.C.Stevens, C.Leblanc Fisher. Assessing urban forest effects and values, Chicago's urban forest. USDA Forest Service, 2010. http://www.treesearch.fs.fed.us/pubs/34760

[9] Oudenhoven, A.P.E. van, K.Petz, R.Alkemade L.G.Hein, R.S. de Groot. Framework for systematic indicator selection to assess effects of land management on ecosystem services. Ecological Indicators, vol.21 - p. 110 - 122, 2012. http://edepot.wur.nl/232691

[10] Schouten, I., M.Flanagan, J.Clement. Bomen modelleren met laseraltimetrie. Geo-Info 2012-7, p.3-7. (in Dutch). http://www.geo-info.nl/

[11] Steeneveld G.J., S.Koopmans, B.G.Heusinkveld, L.W.A. van Hove, A.A.M.Holtslag. Quantifying urban heat island effects and human comfort for cities of variable size and urban morphology in the Netherlands. Journal of Geophysical Research: Atmospheres, 2011. http://dx.doi.org/10.1029/2011JD015988

[12] Zeijts, H. van, K.Overmars, W. van der Bilt, N.Schulp, J.Notenboom, H.Westhoek, J.Helming, I.Terluin, S.Janssen. Greening the Common Agricultural Policy: impacts on farmland biodiversity on an EU scale. PBL Netherlands Environmental Assessment Agency, report nr.500136005, 2011. http://www.pbl.nl/en/publications/zeijts

[13] OGC. City Geography Markup Language CityGML Encoding Standard v.2.0. OGC, April 2012.

[14] Rossmann, J., M.Schluse, R.Waspe, R.Moshammer. Simulations in the woods: From remote sensing based data acquisition and processing to various simulation applications. In: Proceedings of the 2011 Winter Simulation Conference. Phoenix, Arizona, 11-14 Dec. 2011. http://www.informs-sim.org/wsc11papers/088.pdf