Macroscopic plant remains from the Meuse River in the Netherlands.

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Samenvatting

Dit rapport gaat vooral over identificatie van macroscopische plantenresten uit monsters genomen van niet - archeologische contexten. De onderhavige studie was gebaseerd op de vraag of bemonstering van accumulaties van botanisch materiaal, welke overblijft na overstroming van de rivieroever, nuttige informatie over aan de rivier gerelateerde flora zou kunnen opleveren. Voor dit doel zijn verscheidene oppervlakte monsters genomen van gedroogd botanisch materiaal, afkomstig van de Maasoever in Nederland. Een geanalyseerd monster bleek 725 identificeerbare plantendelen te bevatten waarvan 649 diaspores, behorende tot 65 verschillende plantensoorten uit 34 families. Hoewel deze studie niet bedoeld was voor het bestuderen van hydrochorie, zijn sommige adventief planten voor de Maas bevestigd vanuit het onderzoek.

Summary

This report is mainly about identification/ of macroscopic plant remains from samples taken from non - archaeological contexts. The study was based on the question if sampling of accumulations of botanical remains from river depositions after overflow could provide useful information on plant remains transported by the river. For this purpose, several surface samples of extremely dried botanical material have been taken from the Meuse River shore in the Netherlands. One analysed sample appeared to contain 725 identifiable plant parts, among with 649 diaspores, belonging to 65 different species from 34 plant families. Though this study was not meant for studying hydrochory, some adventitious plants could be confrimed for the Meuse river.

Résumé

Ce rapport ce concerne principalement sur l 'identification des restes végétaux macroscopiques d' échantillons prélevés dans des contextes non - archéologiques. L'étude a été basée sur la question de savoir si l'échantillonnage des accumulations de restes botaniques des dépôts fluviaux après le débordement de la fleuve pourrait fournir des informations utiles sur les restes végétaux transportés par la rivière. À cette fin, plusieurs échantillons de surface de matériel botanique extrêmement séché ont été prélevés sur la rive de la Meuse aux Pays-Bas. Un échantillon analysé semblait contenir 725 parties de plantes identifiables, parmi 649 diasporas, appartenant à 65 espèces différentes de 34 familles de plantes. Bien que cette étude ne soit pas destinée à l'étude de l'hydrochore, certaines plantes adventices pourraient être confiées à la Meuse.

Note: this report is not based on standards of applied science, such as predicted and applied in official reports for scientific institutes in applied science (NEN, KNA 4.0, BTL, Guidelines for hydrobiology, etc.).

Introduction and aims

Macrobotanical plant remains are studied in applied sciences such as archaeobotany (Jacomet & Kreuz, 1999; Waters, 1992; Pearsall, 2015; Hastorff & Popper, 1988) and forensic botany (Miller et al., 2005; Ferri et al. 2009). In all cases, defined samples are taken to examine remains by identification and analysis. The essential identification of macrobotanical remains is not only depending on skills of the person analyzing the material. Plant remains naturally disintegrate time related in different ecological cycles, so occurrence of identifiable plant remains from samples are highly depending on special preservation contexts, especially those preventing natural deterioration processes (Kooistra, 1996). This means plant remains are in a certain stage of decomposition, depending on the specific context and time showing specific taphonomy (e.g. Dincauze, 2000).

The Meuse River from its source(s) at Pouilly- en Bassigny in France at an altitude of + 409 a.s.l., up to the sampling location at Geulle Dorp in the Netherlands at + 40 m a.s.l., has a length of about 700 km and together with its many attributes, which all are possible dispersion routes for seeds, which is established in several studies (Imbert E, Lefèvre F (2002); Jaquemin et al. 2006; Jaquemin et al.2010). In theory many different plant species could be found in samples taken from the river shore even though the Meuse river contains several barriers; only the Belgian Meuse is 117 km long, completely channeled with 13 locks, accommodating vessels up to 1350 tons. Other obstacles are found at e.g. the hydroelectric station of Lixhe in Belgium and at the ship lock at Maastricht Limmel in the Netherlands, where the Meuse river is split off with the Julianakanaal. Diaspores (seeds and fruits) found in the samples both could be plants using hydrochory, or accidentally end up in the samples (commonly using non - hydrochorous dispersion, or a mix of dispersion types).

Moreover, the Meuse River passes many smaller and bigger cities like Charleville - Mezières in France, Liège in Belgium and Maastricht in the Netherlands, which all are possible sources for botanical remains like diaspores of wild flowers and trees, kitchen waste, garden waste, plants from agriculture, etc.. Usually this study is made in relation with vegetation reconstruction from the past or at present (see e.g. Sigafoos, 1964; Collinson, 1983; Nilsson et al., 2010).

Insight in macroscopic plant remains in river depositions could be helpful to understand how accumulations of plant remains end up at *one specific location* (see e.g. Drake, & Burrows, 1980, Merrit & Wohl, 2002). Such accumulations could be perfect for study of macroscopic remains when sampled from litter / soil sediments. This study however was basically not about hydrochory, but about the question whether this type of accumulations (i.c. surface concentrations of macrobotanical remains) would contain a wide variety of identifiable remains so would be suitable for further specific study.

Among the river shore, river deposits at the surface are containing botanical material (large and small dried branches, stems of plants, seeds, leaves, fruits, cones, etc.), which might be suitable for study of macrobotanical materials.

Research questions

- Is it possible to get useful information from botanical remains from seasonal river deposits, taken from surface locations, regarding the *different* conditions of preservation during river transport or post depositional (waterlogged, fresh, charred and / or fresh)?
- Is this context an appropriate context for studying macroscopic plant remains and especially *diaspores* from a non – archaeological context?
- Is there anything to say about the preservation of macroscopic plant remains (in relation with the river)?

Methods

Sampling

It was clear a sampling method from botany could not be used (i.e. transect - based method for macrophyte sampling) so the sampling method was closely connected with sampling from preassigned ground features, like in archaeological fieldwork, following best expectation pattern. Dried out botanical material has been river deposed either in small isolated heaps or spread over larger rectangular areas at a local altitude of ca 3,5 – 4,0 meters above (current) seasonal river level in correlation with (last) peak flood level of the river. This dried material often was accompanied by more large plant material like river rounded branches of trees and even (large parts of) tree trunks. So, it was chosen to do stratified sampling (best visible) concentrations, *limited* to these locations to avoid random picking up seeds from too large areas and *not to* sample those locations where it would even be unclear if any botanical materials have been deposed by the river.[1] Large rectangular depositions that could be up to ca, 7- 10 meters long but only 0,5 - 1 meter wide and isolated heaps (noticed up to ca 2 m² total sampling surface) were chosen to take the samples, in both cases only 0,5 m² of the surface has been used for sampling, making the quantity of starting material unequal in percents of total sampled surface. In this case, total surface depends on visibility of botanical remains at the surface, which of course is not a very accurate method, but is a method in stratified sampling to avoid sampling units with no macro botanical remains at all.

At Geulle Dorp, only two appropriate sampling locations could be localized, which were qualified by the following conditions:

- the deposition shows a concentration of botanical material, visible by the naked eye
- the deposition is well accessible to take samples for analysis of smallest seed types (meaning sampling top surface of the soil at sample location).. So it is possible to take a sample from 0,5 m² of the total surface in *open* area (no abundant vegetation, no trees growing in the direct vicinity, etc.)

Fig 1. The sampling location at Geulle Dorp on a map
of the Netherlands and Limburg

Several samples were taken from river deposits which have been made during january-february 2016 at an estimated height of ca 2,5 - 3,0 m. above current river water level at sampling date monday 19 September 2016, which is in the period of the river lowest

[1] This immediately implies samples were taken from previously chosen locations, which were chosen for the ‘expected presence of research material

waterlevels during the year. This report is about anlaysis of sample 433, the other samples will be described in a follow up report.


Fig 2. The sample location near Geulle Dorp.
The samples have been taken a little higher on the shore.


Fig 3. Surface of sampling site 370, showing macroscopic botanical remains,
mainly containing dried branches and stems, among it diaspores..

From the limited 0,5 m² sampling unit large specimens (> ca 2, 0 cm), fruits / seeds were picked by hand while possible specimens with smaller dimensions (0, 5 - 2, 0 cm (M) and < 0, 5 cm (S) could show up from samples taken with a small shovel. For M and S, a plastic bag of 1liter has been filled and the weight of the material was in both cases ca 120 - 130 grams/ l, showing the collected material had been extremely dried.

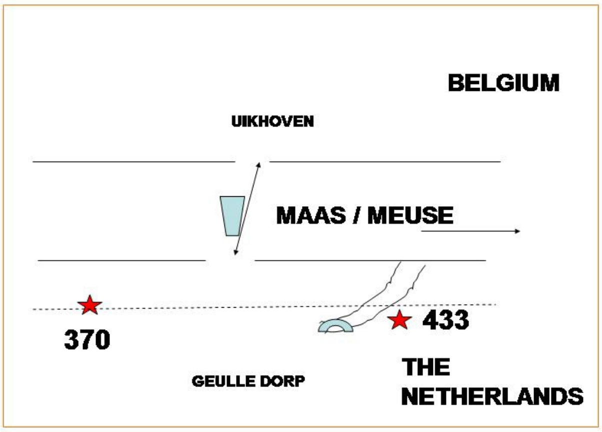

Fig 4. Schematic map of sampling locations at the shore near Geulle – Dorp
in the Netherlands

5Analysis
After sampling, the samples were weighed and sorted out for identification and analysis.
First, well visible large plant remains were sorted out from the samples, than the smaller parts were examined using a magnification of 10 x (simple hand- magnifier). For the smallest section a binocular with magnifications up to 20 - 40 X has been used, together with a DigiMicro Lab 5.0 magnification unit for digital screen- projection and imaging.
The botanical remains were sorted out by plant - part type (seed, fruit, branch, perianth, etc) while further analysis was carried out to make identifications (up to different plant family) or, if possible, till the level of species.
For identification of plant parts, fruits and seeds specific literature has been consulted (see references / bibliography at the end of this report) together with a a botanical reference collection (botanical reference collection of the author, ca 1200 specimens, mainly containing diaspores,stems, Pinaceae needles and dried perianths).

Local flora
To avoid bias in the results, it is important to know the local vegetation to exclude local vegetation from the list of determinations. For this reason, local vegetation has been noted: wild flowers from the shore and trees in a wider environment up to ca 300 m (see Appendix A). It is clear similar plant remains with other conservation forms than 'fresh/ dried' are definitely not from the sampling location, at the same time it is not possible to state plant remains in fresh/ dried conservation have been contaminated from the sampling site either. This means there will always be a bias in plant remains in conservation state 'fresh / dried', not knowing its origin; in practise, species from the samples scarcely coincide with local flora species.

Preservation
Botanical remains from the samples appear in various preservation -types,showing change in colour, texture and completeness. Colours might change in a range between black and brown, depending on the waterlogged situation, till very pale and light grey if sundried (bleeched out). All material was extremely dry (120 - 130 g/ l); dehydratation after being in the stream must have taken place during the months on the shore by wind and sun. The dried botanical remains need no further treatment after analysis and are stored in small plastic boxes and bags. Black waterlogged type plant remains appear to be very fragile, and are stored in small boxes.

Fig 5. Example of changing colour in fruit of *Corylus avellana / americana* ranging in colour from grey – white(wind/ sun dried) till black (waterlogged) Fresh specimens also are present in the sample.

Decolorization of seeds coats occurs in different cirumstances, like it is well visible with oak fruit (Quercus) or chestnuts (Hippocastaneaceae) , that turn from their original brown color when ripe to black during decomposition – in normal cirumstances (surface on soil and moist) .
Seeds from the samples that have been discolorized appear black as result of rivertransport and have been dried afterwards. E.g. fruit of Chenopodiacea (Amaranthaceae) has been found before maturity in the current year(2016), so should originate from last year (autumn 2015) and therefore this is at least almost one year old. The dried specimens appear in average more large sizes, caused by waterlogging.
This ' waterlogged' preservation as described could be considered an initial stage of waterlogging (exclusion of air) that could have been interrupted by many variables, of which one is the deposition at the river shore, resulting in discolorization and drying out. Glued materials like sandgrains or other plant parts are suggesting a longer stay in mud or clay deposits.
Waterlogging means preservation in anaerobic conditions, created by constant wetting and by the action of polyphenols (see e.g. Dimbleby, 1978).
Waterlogged seeds swell and get heavy and are easily deteriorating at room temperature. Discolored botanical remains from the samples show deterioration after deposition at the river shore, like fissures and cracks of seedcoats, dissolving of the endocarp and sometimes total fragmentation of seedcoats.
Note: in preservation, only 'fresh' means seeds/ fruit has exactly the same appearance like specimens recently taken from a parent plant (most viable seeds). 'Fresh / dried' means decolourisation took place (e.g. from brown to light grey). 'Waterlogged' means decolourisation and / or some change in size took place by degradation of the soft tissues (like fissures in the seed coat) and usually the colour is black (see e.g. Jones Tinsley,and Brunning (2007). In condition (see table below) 'whole' does not mean "undamaged"; fragments could be an 'intact fragment' e.g. half a seed consisting of s ingle cotyledon, or appear as whole damaged or undamaged units of a plant, e.g. *Populus alba* in the list below has been found twice a complementary half (both damaged), it is uncertain whether these belong to the same seed as they are damaged.

4. Results of analysis

Descriptions of sample

Sample nr. 433: sample location near stream in reconstructed area outside local dike. Ruderal terrain with many flowering plants (see appendix a). All fractions, (S, M. L) Geulle Dorp / coordinates: Geulle a/d Maas 50.929648, 5.734440. Sample taken 20 – 09 – 2016. Total surface: 0,80 x 1,10 m = 0.88m². Sampled surface 0,50 m² (= 56.8 % of total surface).
433 S / M: Very dry materials very rich in stems (mainly of Poaceae) and with organic materials (plant parts, Mollosca and Insecta), seeds well visible in M.
433 L: Handpicked - no description available.

Table 1. Identified plant species from M433. ; Plant - part = plant - part or dispersion unit. For the use of the term ' waterlogged' see section about preservation.

f = fresh: the specimen looks unchanged by any processes
w = waterlogged: the specimen appears very dark / black, as in waterlogged condition
d = dried: specimen appears very light (bleeched) decoloristaion
(C) = cultivar

Species / Family	N	Preservation-type	Plant - part	Condition
ACERACEAE				
Acer sp.	23	waterlogged	fruit	fragm.
HIPPOCASTANEACEAE				
Aesculus hippocastanum	1	waterlogged	fruit	whole (1 cm)
Aesculus hippocastanum	7	waterlogged	seed	whole
Aesculus hippocastanum	3	waterlogged	seed	fragm.
Aesculus hippocastanum	1	waterlogged	fruit	whole [small specimen]
Aesculus hippocastanum	1	waterlogged	fruit	fragm..
BETULACEAE				
Alnus glutinosa	1	waterlogged	cone	whole
Alnus sp.	15	waterlogged cf.	cone	fragm (inner part
Alnus sp.	3	waterlogged	catkin	fragm.
Alnus glutinosa	142	w=73 f=69	fruit	whole
Alnus incana	14	waterlogged	fruit	whole
Betula pendula	1	waterlogged	fruit	whole
Betula pendula	2	dried/ fresh	seed	whole
Betula pendula	1	waterlogged	bract	fragm.
Carpinus betulus	9	waterlogged /dried	seed	whole
Carpinus betulus	2	waterlogged/ dried	fruit	fragm
Corylus avellana	25	variable	fruit	whole

FAGACEAE				
Fagus sylvatica	13	waterlogged	fruit	whole
Fagus sylvatica	14	waterlogged	bracts	whole
Fagus sylvatica	21	waterlogged	bracts	fragm.
Fagus grandifolia (C)	3	waterlogged	bracts	fragm
Quercus rubra	1	waterlogged	fruit	fragm..
Quercus robur	2	waterlogged	fruit	fragm..
Quercus sp.	1	waterlogged	capule	whole
Quercus sp.	1	waterlogged	seed	whole
Quercus rubra	4	waterlogged	fruit	whole
Quercus sp.	1	waterlogged	fruit (developing)	whole
OLEACEAE				
Fraxinus excelsior	42	waterlogged/ charred	seed	whole
Fraxinus excelsior	3	fresh/ dried	fruit	fragm
PLATANACEAE				
Platanus x hispanica (C)	4	waterlogged	unripe cone	whole
CORNACEAE				
Cornus sanguineus (C)	4	waterlogged	fruit	whole
PINACEAE				
Cupressus cf. sempervirens (C)	1	fresh/dried	twig	fragm
Chamaeciparus nootkatensis(C)	1	fresh/ dried	twig	fragm.
Cupressus sp. / Chamaeciparus sp. (C)	1	fresh/ dried	twig	fragm.
Picea sp. (C)	2	fresh/ dried	twig	fragm.
Picea sp. (C)	1	fresh/ dried	twig	fragm.
Pinus cf. sylvestris	1	fresh/ dried	cone scale	fragm
Pinaceae	1	waterlogged	cone	fragm
Thuja sp. (C)	4	fresh/ dried	twig	fragm.
BUXACEAE				
Buxus sempervirens	1	dried	leaf	whole
ADOXACEAE				
Sambucus nigra	10	waterlogged	seed	whole
Sambucus racemosa	3	fresh/ dried	fruit	whole
SALICACEAE				

Populus alba	2	waterlogged	seed	fragm
Salix alba / fragilis	77	fresh/dried/ waterlogged	fruit	whole
Salix alba / fragilis	12	fresh/dried/ waterlogged	fruit	whole
ASTERACEAE				
Sylibum marianum	1	waterlogged	fruit	whole, pappus absent
Tripleurospermum maritimum	2	dried	capitulum + seed	whole
Crepis capillaris	1	dried	fruit	whole, flattened
Conyza canadensis	22	fresh/ dried	fruit	whole, pappus
Eupatorium cannabinum	1	fresh	fruit (+ pappus)	whole
Taraxacum officinale	1	fresh	fruit	whole
Lactuca sativa (C)	1	waterlogged	fruit	whole
Centaurea scabiosa	1	dried	capitulum	part
VITACEAE				
Vitis vinifera (C)	23	waterlogged/ charred	seed	whole
POLYGONACEAE				
Persicaria hydropiper	1	waterlogged/ dried	fruit	whole
FABACEAE				
Medicago lupulina	1	fresh	fruit	whole
Vicia cf. cracca	2	dried	seed	fragm
ACTINIDIACEAE				
Actinidia deliciosa (C)	18	waterlogged	seed	whole
CUCURBITACEAE				
Cucumis melo (C)	3	fresh	seed	whole
Cucumis sativus (C)	1	fresh/ dried	seed	whole
BORAGINACEAE				
Symphytum officinale	13	waterlogged	fruit	whole
MORACEAE				
Ficus carica (C)	39	dried	seed	whole
CARYOPHYLLACEAE				
Saponaria officinalis	1	waterlogged	seed	whole
Agrostemma githago	1	waterlogged	seed	whole
Cerastium fontanum ssp.	1	fresh	seed	whole

holosteoides				
Silene dioica	1	dried	seedpod	whole
FUMARIACEAE				
Pseudofumaria alba	1	waterlogged	seed	whole
LAMIACEAE				
Lycopus europaeus	1	waterlogged	seed	whole
ARALIACEAE				
Hedera helix	1	waterlogged	fruit	whole
IRIDACEAE				
Iris pseudacorus	4	fresh	seed	whole
POACEAE				
Poa angustifolia	1	dried	floret	whole
Festuca pratensis	1	dried	floret	whole
Panicum capilare	1	waterlogged	fruit	whole, attached at Persicaria lapathifolia ventral view
Bromus lepidus	3	fresh	floret	whole
Zea mays	1	dried	corncop	part
FABACEAE				
Trifolium repens	2	dried	seed	whole
SPARGANIACEAE				
Sparganium angustifolium	2	1 waterlogged + 1 fresh/ dried	fruit	whole
ROSACEAE				
Prunus cerasifera (C)	1	fresh	exocarp	whole
Prunus domestica ssp.insititia (C)	1	fresh	fruit	whole
Prunus avium /cerasus	39	variable	fruit	whole
Prunus avium /cerasus	1	fresh	fruit	half
Prunus laurocerasus (C)	1	fresh / dried	fruit	whole
Rosa sp.	1	waterlogged/ dried	stem + spines	fragm.
Rubus fruticosus	3	fresh, dried	fruit	whole
Fragaria moschata	1	fresh	fruit	whole
Fragaria x ananassa	1	fresh	fruit	whole
PLANTAGINACEAE				
Veronica hederifolia	1	fresh	seed	whole

AMARANTHACEAE				
Chenopodium album	4	waterlogged	fruit	whole
Chenopodium murale	1	waterlogged	fruit	whole
Chenopodium glaucum	1	waterlogged	fruit	whole
Atriplex patula	15	waterlogged	fruit	whole
Phytolacca americana	2	waterlogged	seed	whole
SCROPHULARIACEAE				
Chaenorhinum minus	1	fresh	seed	whole
POLYGONACEAE				
Rumex obtusifolius	1	waterlogged	fruit + perianth	whole
Rumex hydrolapathum	2	waterlogged	fruit + perianth	whole
Persicaria lapathifolia	1	waterlogged	fruit	whole + attachment Panicum capilare
Rumex obtusifolius	1	waterlogged	perianth	fragm.
Rumex hydrolapathum	1	waterlogged	fruit	whole
Rumex sp.	1	waterlogged	fruit + perianth	fragm.
Persicaria hydropiper	1	waterlogged/ dried	fruit	whole
OXALIDACEAE				
Oxalis dillenii	1	waterlogged	seed	whole
CYPERACEAE				
Carex otrubae	1	dried	urticle	whole
Carex elongata	1	dried	urticle	whole, damaged
Carex limosa	1	dried	urticle	whole
Carex vulpinoidea	1	waterlogged	fruit	whole

Indeterminatae (seed) :11
Total diaspores / L (for 125grams = 1/8 L): 649
Total plant parts / L (for 125grams = 1/8 L): 725

Problems in identification

It was not always possible to identify botanical remains up to the level of species, due to a lack of typical characteristics to distinguish species from the same family. Such problems occurred especially in Fabaceae, incidentally for other families like Aceracea, Rosaceae and Fagaceae. Absence of typical identification characteristic was caused by taphonomic processes, mainly in intense decolourisation often in combination with erasing Id -features like spots or dots, lines, etc., or by fragmentation,(e.g. making the exocarp very scurfy) and sometimes by deformation (transformation of a part of the shape) of diaspores, like dented fruit of Carex and seed coat remains. Working with the Digital Seed Atlas of The Netherlands (Cappers, Bekkers Jans, 2006) was a pleasure; nevertheless, the "old" Seed Atlas of Beijerinck (Beijerinck, 1976) was consulted for several (average) dimensions of seeds and fruits, especially in relation with seed shape variety. Adittionaly a seed and plant parts reference collection used for identification could only obtain specimens from one sampled plant or one sampling location, giving limited view in seed variety within a species. Some seeds were too far in detoriation to be certain about its possible family (N= 11) and are listed indeterminatae.

Results

A total of 725 plant parts, belonging to 65 species from 34 plant families have been identiciated from the sample. Among these plant parts, 649 have been identified as diaspores . These spoecies belong, as expected to a wider range of plant types (ruderals, trees, shrubs, etc), ranging from diaspores from trees till seeds flushed from kitchen's waste or coming from private gardens. This is discussed below.

The high number of total identified plant parts is due to some species that produce high numbers of diaspores like black alder (*Alnus glutinosa*) and ash (*Fraxinus excelsior*) , while kiwifruit (*Actinidia deliciosa*) , fig (*Ficus carica*) and grape (*Vitis vinifera*) produce much seeds, that could in theory originate from single fruits.

Trees

Both trees, wild flowers and cultivated plants appear in the samples. A total of 22 decidious trees appear in the sample, of which some are typical for hydrochorous dispersion (*Alnus* sp.) while trasport in the river seems to be a secoundary dispersion method from original anemochory (e.g. *Acer* sp., *Betula* sp. *Fraxinus* sp.). More large seeds and fruits like from Hippocastaneaceae and Prunus sp. originate from trees that have their growing place in the vicinity of the river. Bracts of American beech (*Fagus grandifolia)* are quite different from those of the common *F. sylvatica* and with the London planetree (*Platanus x hispanica*) (syn. *P. acerifolia)* we deal with trees known from city parks / alleys and arboreta, or originating from private gardens. Conifers (N=6) have been identified by either cones or twigs / needles and beside of *P. sylvestris* and *Picea* sp. these species are commonly found cultivated in private gardens or parks.

Cultivated plants

Several plant species are exotic cultivars and must have ended in the river by sewerage, e.g. muskmelon (*Cucumis melo*) cucumber (*Cucumis sativa*) and (fig (*Ficus carica*) are kitchen vegetables. Kiwifruit (*Actinidia deliciosa*) has been reported in 2005 in Floron Nieuws (see reference) and kiwifruit seems to spontaneously grow from discarded fruits, as known from some observations in Belgium (Neerpelt, Beringen). Cultivated strawberry (*Fragaria x ananassa*) is known from the Rhine shore (Odé and Beringen, 2004) and south of the sampling location in both South - Limburg and Belgium this species is cultivated on a large scale. The grape (*Vitis vinifera*) could either be from kitchen waste or from cultivated plants along the river side, in theory in origin from France. A single leaf was identified as belonging to box (*Buxus sempervirens*) and twigs / needles from conifers from various species (*Cupressus* sp., *Thuja* sp. and *Picea* sp.). Pokeweed (*Phytolacca americana*) is a common garden plant, often found wild or adventive and usualy dispersed by birds. All these latter species could be part of garden waste or could grow in gardens along the river.

Wild flowers

Part of the wild flowers confirmed by identification of their plant partts belong to river bound habiratf lowers, like common soapwort (*Saponaria officinalis*), gipsywort (*Lycopus europaeus*) Yellow Iris (*Iris pseudacorus*), *f*loating bur-reed (*Sparganium angustifolium*) and various members of sedges *Carex sp*. Usual ruderal flowers are well represented too, like

sorrel (*Rumex* sp.), common comfrey (*Symphytum officinale*) pale persicaria (*Persicaria lapathifolia*) and black medic (*Medicago lupulina*). Besides of these common species, the find of a single seed of the southern yellow wood sorrel (*Oxalis dillenii*) is remarkable, this species has been reported in the year 2000 as present in the Netherlands from fluviatile context (Van Moorsel , Beringen and Odé, 2000), also known by the author from the inner city of Maastricht.
Pale persicaria (*Persicaria lapathifolia*) has been found attached with common witchgrass (*Panicum capilare*), showing several seeds have been glued together in clay rich layers of the riverbottom before final deposition at the shore.

Other finds from sample M433
Normal river bound issues were noticed in the samples like dried specimens and/ or parts of Insecta and Mollusca. All samples were polluted with small rounded polystyrene foam balls in seed size (1-3 mm) and short tubular semi transparent hard plastic objects ca. 3 - 4 mm cross section (48 in sample 433), interpreted as industrial plastic pellets.

Preservation and taphonomy
Botanical remains show a wide range in preservation between 'remarkably fresh' till 'fragmented", in the latter case showing features in plant taphonomy: ruptured seedcoats, ultimate fragmentation, especially visible in the fragmented and dissapearing wing structures of maple (*Acer* sp.), the appearance of horse chestnut (*Aesculus hippocastanum*) with its black seedcoat and dissolved inner structures (dissolved until a white powder by heat) and in seed and fruit of oak (*Quercus* sp.) where dissolving inner structures, fragmented seedcoats and altered surface structure is the result of intense weathering in oxygen rich conditions. The opposite low oxygen condition has also been confirmed, where waterlogging of seeds highly influences decreasing viability of seeds (Pérez-Ramos & Marañón, 2009), depending on 'typical'dispersion type, e.g. yellow iris *Iris pseudocorus* having the longest floating time of any of tested species, namely 429 days (Van den Broek, Van Diggelen and Bobbink, 2005). In this case, seeds of *I. pseudacorus* have been found both waterlogged and deteriorated and fresh. Still, waterlogging also *prevents* further deterioration, though morphological changes appear. Of the fruit of black elder *Alnus glutinosa* (total N= 142) 73 seems to be watterlogged, and 69 appear fresh. This distinction is visible by the intense black colour and cracks at the surface during the drying process for waterlogged specimens, while fresh specimens show a more natural original dark brown colour and their surface shows no change while drying. A total of 11 seeds could still be identified as original seeds, but had deeply incised seedcoat- fragments which was often the only part of the seed. This was causing problems with reconstruction of original size and shape, especially in lack of additional characteristics like monochromatism, ribs or e.g. a bubbled surface. These specimens all have been in changing waterlogged conditions, which would have been causing a more rapid deterioration of the fruit. Bleeched specimens of *Corylus* sp. also show change in surface texture, especially a kind of frayed surface.

Discussion
Botanical remains reach the surface during runoff by the river. Taxa could be overrepresented or underrepresented in the samples due to different characteristics of diaspores themselves (underrepresented: too small, too soft, seeds of non deciduous plants) or external factors (not renewed annually (Holyoak, 1984)), or simply by different numbers of seeds / plant. The results in this report are showing that targeting sampling of botanical materials from the river shore is providing (enough) useful material to give some general information about seed dispersal by / along the river.

For the purpose of this study, which was to determine if botanical material from the surface of the river shore would provide sufficient identifiable plant parts , the total of 649 identifiablle diaspores was much more than expected., so could be called a success. However, for any conclusions from the total group, botanical remains appear in different states of preservation, which makes it difficult to see them as one homogeneous group: the only connecting factor is, they end up in the same sample.
The question reamins if this sample gives any good representation of the (current) botanicall river content. At least the adventitious character of some species, like *Oxalis dillenii, Actinidia deliciosa* and *Fragaria x ananassa* could be confirmed for the Meuse river from the sample. This report is about the first analysed sample, taken in 2016.; it would be appropriate to repeat the sampling in other years and see how different or equal the results would be.

Appendices

A. List of local flora at sampling location M433 at the Meuse river shore Geulle – Dorp
The following species (44 plant species and 8 trees) have been noted 21/ 09/ 2016. It is not meant to give a complete list, due to seasonal inventory. Poaceae are not counted.

TREES (within 100 - 200 m)
Aesculus hippocastanum
Alnus glutinosa
Juglans regia
Malus sp.
Prunus cerasus
Pyrus communmis
Salix alba
Fraxiunus excelsior

WILD FLOWERS
Achillea ptarmica
Artemisia vulgaris
Bidens frondosa
Buddleja davidii
Carduus crispus
Chenopodium album
Chenopodium polyspermum
Convolvulus arvensis
Conyza canadensis
Daucus carota

Epilobium ciliatum
Epilobium hirsuta
Eupatorium cannabinum
Galeopsis angustifolia
Galinsoga sp.
Impatiens glandulifera
Linaria vulgaris
Lotus corniculatus
Lycopus europaeus

Lythrum salicaria

Matricaria recutita
Melilotus officinalis
Mentha rotundifolia
Odontitus vernus
Pastinaca sativa
Persicaria maculosa
Plantago lanceolata
Plantago major ssp. major
Polygonum aviculare
Ranunculus repens

Rorippa islandica
Rubus fructicosus
Rumex obtusifolius
Rumex sanguineus
Rumex crispus
Senecio viscosus
Scrophularia nodosa
Sonchus oleraceus
Tanacetum vulgare
Taraxacum officinale

Trifolium repens
Tripleurospermum maritmum
Urtica urens
Xantium spinosum

B Preservation of seeds and fruits (some images)

Fig 6 . Winged fruit of maple (*Acer*.sp) from sample 433; in the deterioration - process the wing disappeared and the colour gets more intense black

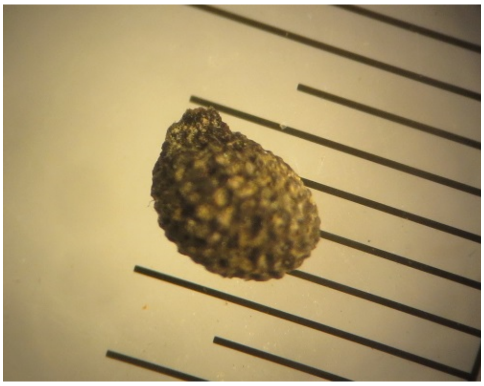

Fig 7. A waterlogged seed of kiwifruit (*Actinidia deliciosus*), found in sample 433 (Magnification 20 x)

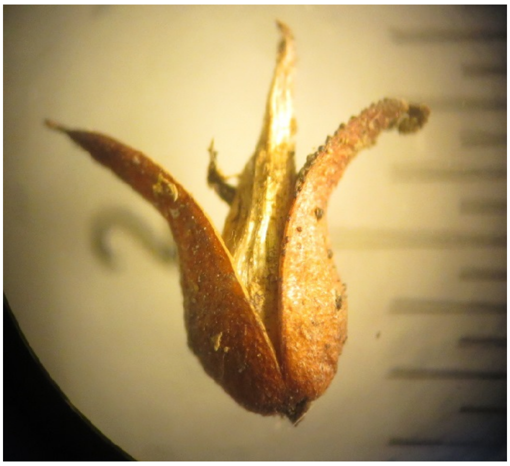

Fig 8. Fresh fruit of white willow (*Salix alba*), still containing its seed while in dehiscence, using hydrochory as dispersion (sample 433)

Fig 9. Yellow woodsorrel (*Oxalis dillenii*) seed Preservation: waterlogged Scale = 0,5 mm note: advetitious

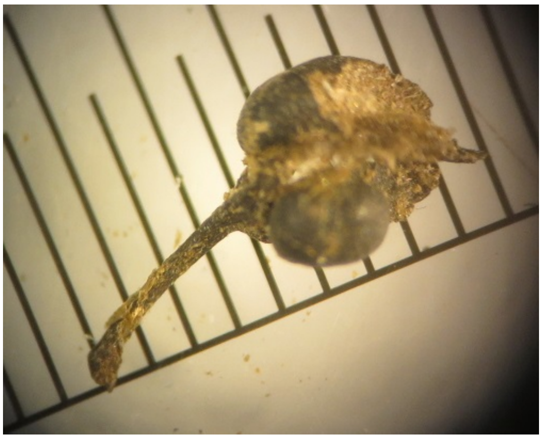

Fig. 10. Wheathering of a perianth of (*Rumex obtusifolius*) in waterlogged condition (sample 433) Magnification 20 x

Fig. 11 Variation in preservation of fruit of white willow (*Salix alba*,); left: dried (decolourization) middle: fresh dried and right ‘waterlogged (decolourization) . Sample 433, magnification 20 x

Fig 12. Inner cone fragment of black elder (*Alnus glutinosa*)

Fig. 13. Twig of cypress (*Chamaecyparis* sp.)

Fig 14. Seed of yellow iris (*Iris pseudocarpus*) (waterlogged)

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