Quantifying biomass production in floodplains along the Rhine river distributaries

K.R. Koopman[a,e]*, M.W. Straatsma[b], D.C.M. Augustijn[c], A.M. Breure[a,d], H.J.R. Lenders[a], S.J. Stax[a], & R.S.E.W. Leuven[e]

[a] *Department of Environmental Science, Institute for Water and Wetland Research, Radboud University, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands*

[b] *Department of Physical Geography, Utrecht University, P.O. Box 80115, 3508 TC Utrecht, The Netherlands*

[c] *Twente Water Centre, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands*

[d] *Centre for Sustainability, Environment and Health, National Institute for Public Health and the Environment (RIVM), P.O. Box 1, 3720 BA Bilthoven, The Netherlands*

[e] *Department of Animal Ecology and Physiology, Institute for Water and Wetland Research, Radboud University, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands*

Keywords — Room for the Rivers, Riverine management, Ecosystem services

Introduction

River systems provide valuable functions and services to mankind, such as: water supply, transport capacity, sediment and biomass. As fossil resources are depleted fast, the need for alternatives increases. Biomass produced by riparian vegetation is a valuable riverine ecosystem service and has various applications, for example bioenergy production. In order to quantify how much biomass can be harvested, the river systems' potential for biomass production needs to be determined. We developed an approach for quantifying annual above-ground biomass production of river floodplains systems (Koopman et al., 2018). Next, our approach was applied to calculate spatiotemporal development of biomass production in floodplains along the Rhine river distributaries in the Netherlands (the rivers Waal, Nederrijn-Lek and IJssel). Biomass production was calculated for the years 1997, 2005, 2008 and 2012. During this period these river distributaries underwent different management measures, natural succession and land use change, which potentially affected the biomass production.

Method

Study area and mapping

The Rhine river distributaries and their floodplains have been regularly mapped over the period 1997-2012 using the Ecotope System for National Waterways (Van der Molen, 2003). The ESN classifies the riverscape into ecotopes, which are homogeneous landscape units based on hydromorphological, geo-morphological, ecological and land use characteristics. The maps are available for the years 1997, 2005, 2008 and 2012. The riverscape underwent many changes due to natural vegetation succession, land use changes and measures of the Room for the River programme (e.g., side channel construction, floodplain lowering and removal of summer dikes; Silva et al., 2001; Van Stokkom et al., 2005; Straatsma et al., 2017).

Biomass production of floodplains

Biomass production rates (ton_{dm} ha^{-1} yr^{-1}) for woody and non-woody biomass were linked to nine corresponding vegetation classes present in floodplains along the three distributaries. These vegetation classes were retrieved by aggregating ecotopes of the ESN based on vegetation with similar roughness values (Van Velzen et al., 2002). Next, biomass production of floodplains was calculated by multiplying the biomass production rates with the surface area of corresponding vegetation classes. The biomass production values were aggregated at floodplain scale (177 sections) and distributary scale.

Results

Total biomass production decreased most in floodplains along the IJssel river, followed by the Waal and Nederrijn-Lek rivers, respectively (Table 1). Annual biomass production decreased in most floodplains (Fig. 1). Decreases ranged up to $10.1 \cdot 10^3$ $tons_{dm}$,

Table 1: The annual above-ground biomass production of the Rhine river distributaries for the years 1997, 2005, 2008 and 2012. Biomass is given in tons dry mass.

Distributary	1997	2005	2008	2012
Waal river	7.2E+04	7.2E+04	6.3E+04	6.1E+04
Nederrijn-Lek river	7.1E+04	6.6E+04	6.4E+04	6.2E+04
IJssel river	9.9E+04	9.3E+04	9.1E+04	8.6E+04

* Corresponding author
Email address: kkoopman@science.ru.nl (K.R. Koopman)