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SUPPLEMENTARY MATERIAL TO THE ARTICLE:

Affek, A.N., Solon, J., Kowalska, A., Regulska, E., Wolski, J., Kołaczkowska, E. (2024). The potential of Polish forests to provide ecosystem services. Geographia Polonica, 97(1), 65-90. https://doi.org/10.7163/GPol.0269

Appendix

Table A1. Brief description of indicator construction and data sources. A detailed description is included in the Polish-language report published by WWF (Affek et al., 2023)

Ecosystem service	Indicator	Indicator construction	Source data
Wood	Timber that can be harvested annually, expressed in price-equivalent volume of pine wood [m^3/ha per year]	The indicator shows annual volume increments in mature forests calculated as the difference between the volume in 2022 and 2021 at the sub-compartment level, separately for individual tree species, excluding forests where timber harvesting was carried out. The increments [m^3/ha] of tree species other than pine were converted into increments of pine wood according to the price equivalent of large-size wood (assortment group W0) from 2022.	Timber volume of individual tree species in sub-compartments with stands older than 80 years (454,678 records, 266,863 sub-compartments) was obtained from the Forest Data Bank (www.bdl.lasy.gov.pl). The average prices of wood for the eight most popular tree species (pine, spruce, larch, fir, beech, oak, birch, and alder) sold by forest districts were taken from the report of the General Directorate of State Forests (DGLP, 2023).
Forest fruits	Abundance of blueberry fruit per hectare of forest [kg/ha per year]	The indicator shows the potential abundance of blueberry fruit per hectare of forest in each forest sub-compartment with a stand over 80 years old. The empirical model of Grochowski (1990) was used, taking into account the type of undergrowth and the division into lowland and mountain forests.	Data on the forest habitat type and the type of undergrowth cover were obtained from the Forest Data Bank (www.bdl.lasy.gov.pl). For habitats where bilberry is an accidental species, its presence was confirmed based on phytosociological relevés and literature.

Ecosystem service	Indicator	Indicator construction	Source data
Mushrooms / Mushroom picking	Ecological conditions favorable for the occurrence of edible mushrooms, traditionally harvested in Poland	Each sub-compartment with a stand older than 80 years was characterized by the lowest value of six partial indicators (factor limiting the potential): (1) tree species with which fungi form mycorrhiza, (2) soil subgroup, (3) habitat moisture, (4) stand density, (5) vertical structure of the stand, and (6) the average slope determining the forest accessibility for mushroom pickers. The partial indicators were assigned a value in the range 0-1 (from unfavorable to most suitable conditions).	Data on symbiotic mushroom-tree relationships were obtained from the mycological scientific literature. Data on the species composition and structure of forest stands as well as habitat conditions in forest sub-compartments were obtained from the Forest Data Bank (www.bdl.lasy.gov.pl), while data on the average slope – from the Digital Terrain Model with a resolution of 50 m (www.geoportal.gov.pl).
Game / Hunting	Number of red deer possible to be harvested per 10 km^2 of forest per year	The indicator was calculated by combining deer density per forest hunting district and the share of forest habitat types per such a district, which allowed for obtaining deer density differences in forest types.	Tabular data for hunting districts on planned deer harvest were obtained from the Forest Data Bank (www.bdl.lasy.gov.pl). Spatial layers with hunting districts were obtained from Open Forest Data (https://gis.openforestdata.pl).
Honey / Pollination	Size of food base for bees	The indicator took into account the beekeeping value and the cover of 55 most important forest species of trees, shrubs and herbaceous plants providing nectar, pollen, or honeydew used by bees. The value of the indicator is the sum of the product of the ranks of the beekeeping value and the cover of each species considered.	Data on the beekeeping value were obtained primarily from the Great Atlas of Honey Plants (Kołtowski, 2006). Data on the abundance of melliferous species per forest type were taken from the literature, e.g., Matuszkiewicz (2008), Zaręba (1988). Data on the abundance of tree species at the sub-compartment level were obtained from the Forest Data Bank (www.bdl.lasy.gov.pl).
Global climate regulation	Carbon stock in biomass [t/ha]	To calculate the indicator, both above- and below-ground biomass of living trees, as well as biomass of dead wood, were taken into account. Data on standing timber volume was transformed into the carbon stock in total biomass using formulas and coefficients recommended by the IPCC (2003).	Timber volume for sub-compartments with tree stands older than 80 years, divided into tree species, tree layers and age classes, was obtained from the Forest Data Bank (www.bdl.lasy.gov.pl). Dry wood density for all 60 tree species in the database was taken from the Global Wood Density Database (Zanne et al., 2009).
	Rate of carbon accumulation in biomass [t/ha per year]	The annual increase in carbon stocks in biomass was calculated as the difference between 2022 and 2021, taking into account those forest sub-compartments, for which the stock by individual tree species increased during this period, i.e. excluding forests where wood was harvested.	Timber volume of individual tree species in sub-compartments with stands older than 80 years (454,678 records, 266,863 sub-compartments), for 2022 and 2021, was obtained from the Forest Data Bank (www.bdl.lasy.gov.pl).
Local climate regulation / Air purification	Leaf area index (LAI)	The indicator was calculated as the average Leaf Area Index (ratio of leaf area to ground area) for sub-compartments with stands older than 80 years.	LAI values were obtained from a satellite-derived raster map with 333 m resolution (https://land.copernicus.eu/global/products/lai).

Ecosystem service	Indicator	Indicator construction	Source data
Soil erosion control	Coefficient of the protective role of forest vegetation (C)	C coefficient calculated based on the Normalized Difference Vegetation Index (NDVI) according to the formula proposed by van der Knijff et al. (2000).	NDVI values were taken from a satellite-derived raster map with 300 m resolution (https://land.copernicus.eu/global/products/ndvi).
	The difference in the amount of soil potentially eroded between a forest plot and a plot with bare soil [t/ha per year]	Indicator calculated with the help of Revised Universal Soil Loss Equation (RUSLE) (Renard et al., 1997), including the impact of rainfall, runoff erosivity, soil erodibility, slope, and protective role of vegetation (C) calculated based on NDVI. For each 50×50 m pixel, soil erosion was calculated twice: for C=1 (bare ground) and for the actual C. The difference between these values indicates the difference in soil potentially eroded. Values for pixels were averaged for each forest sub-compartment with a stand over 80 years old.	Precipitation for Poland – raster maps from 1970-2000 (https://www.worldclim.org/data/worldclim21.html); Soil erodibility – raster map for Europe (https://esdac.jrc.ec.europa.eu/content/soil-erodibility-k-factor-high-resolution-dataset-europe); Slope – digital elevation model (www.geoportal.gov.pl); NDVI – raster map with 33 m resolution (https://land.copernicus.eu/global/products/ndvi).
Flood control	Water holding capacity of forest vegetation (trees and undergrowth)	The indicator is based on a mathematical formula and coefficient values taken from AWRA-L (Wallace et al., 2013) and vD-B (Zhong et al., 2022) models. The main differentiating variable was the Leaf Area Index (LAI). The water capacity of the forest undergrowth was calculated using the rank method, by ranking interceptive properties of individual types of undergrowth cover. The water capacity of leaves and trunks was taken from the literature.	LAI values were obtained from a satellite-derived raster map with 333 m resolution (https://land.copernicus.eu/global/products/lai). The RT6 product from July 20, 2022 was used in the form of time composition from 60 days. Data on the types of ground cover of individual forest sub-compartments were obtained from the Forest Data Bank, update 2022 (www.bdl.lasy.gov.pl).
Habitat maintenance / Science and education	Number of undergrowth plant species per 400 m^2	The number of undergrowth plant species was determined based on phytosociological relevés. The obtained values were assigned to forest plant associations, separately for each forest region. Then, based on the known relationship between plant associations and forest habitat types (Matuszkiewicz, 2008), the values were averaged for forest habitat types.	Data on the number of species in the relevés were taken from the literature (e.g., Matuszkiewicz, 2007, 2008), unpublished data of forest monitoring conducted by the Forest Research Institute and phytosociological documentation of national parks and Natura2000 sites.
	Number of protected plant species in niche optimum	From the official list of protected plant species (Rozporządzenie, 2014), 96 vascular forest plant species were selected. Then an analysis of the relationship of these species to forest habitat types was carried out. In doing so, information on the ecological requirements and distribution of the species was used.	Data on the distribution and ecological requirements of species were taken from Snowarski (2023) and Zając & Zając (2001).

Ecosystem service	Indicator	Indicator construction	Source data
Recreation	Vegetation and habitat conditions favorable for recreation	The indicator was calculated as the average of six partial indicators defining vegetation and habitat conditions: (1) the number of tree species in the upper stand layer, (2) the percentage of the dominant species in the upper stand layer, (3) stand density, (4) type of undergrowth, (5) habitat moisture, and (6) slope. The partial indicators were assigned a value in the range 0-1 (from unfavorable to most suitable conditions).	Data on the species composition and structure of forest stands as well as habitat conditions in forest subcompartments older than 80 years were obtained from the Forest Data Bank (www.bdl.lasy.gov.pl). Data on slope were taken from the Digital Terrain Model with a resolution of 50 m (www.geoportal.gov.pl).
Health regeneration	The combined effect of phytoncides (beneficial) and allergenic pollen (unfavorable) produced by trees	The indicator was calculated as the difference between the production of phytoncides and allergenic pollen by trees weighted by the average share of tree species in particular forest habitat types. Both the production of phytoncides and allergenic pollen were expressed on the 0-1 rank scale.	Data on tree species composition and the average share of tree species in forest habitat types were obtained from the Forest Data Bank (www.bdl.lasy.gov.pl). Data on the production of phytoncides were taken from scientific literature, while data on pollen allergenicity – from www.pollenlibrary.com.

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