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Microbial/biochemical indicators showing perceptible deterioration in the topsoil due to deforestation

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ABSTRACT

Microbial parameters have been used to monitor changes in the topsoil under different land covers. Soils from five land cover systems common in northern Iran, including virgin natural forest, *Alnus subcordata* C.A.M. plantation, *Quercus castaneifolia* C. A. Mey plantation, *Cupressus sempervirens* var. horizontalis plantation and degraded natural forest were used to assess the effects of land cover changes on soil. We tested the following hypotheses: (i) deforestation would markedly influence topsoil C, N and P microbial ratios which make it distinct from the natural forest and plantations in the long-term, (ii) virgin natural forest and the establishment of plantations promote soil enzyme activities and the fractions of particulate organic matter (POC and PON) and dissolved organic matter (DOC and DON), 30 years after planting. Sixteen samples per land cover were taken from top 15 cm soil and characterized with respect to pH, organic C, total N, N mineralization, NH_4^+, NO_3^-, available P, fine root biomass, enzymes activities (urease, acid phosphomonoesterase, arylsulfatase and invertase), basal respiration (BR), substrate inducted respiration (SIR), microbial biomass-C, -N and -P (MBC, MBN and MBP), POC, PON, DOC and DON. There were no significant differences in BR/MBC, MBC/C_{org}, BR/SIR and MBC/MBN microbial indices among the plantations, virgin and degraded natural forests. The values of soil MBC/MBP were increased, more than one and half-fold, following deforestation (12.82) compared to virgin natural forest (8.53) site. The natural forest and establishment of plantations reduced the ratio of MBN/MBP, while the greater amount (1.14) was observed under degraded natural forest. With replacement in the type of tree species from *Carpinus betulus* and *Parrotia persica* in the natural forest to *Quercus castaneifolia* plantation, almost 30 years after planting, POC/PON increased significantly in the topsoil (13.29), about two-three fold, compared to virgin (7.13) and deforested (3.96) natural forests. The soil DOC/DON ratio varied significantly and it increased by about one and half-fold, following the growth of *Quercus castaneifolia* (2.87) and *Cupressus sempervirens* (2.68) trees compared to the other ecosystems. Based on PCA, virgin natural forest and *Alnus subcordata* plantation presented a good condition of soil fertility, more microbial and enzyme activities with a low ratio of microbial indicators. In general, microbial/biochemical indicators showed perceptible deterioration in the topsoil due to deforestation. As a conclusion, soil enzyme activity, MBC/MBP, MBN/MBP, POC/PON and DOC/DON are robust and sensitive indicators that can be used to measure long-term variations in the topsoil due to changed land cover.

1. Introduction

The rapid expansion of urban space and intense human activities has significantly affected ecosystem services (e.g. regulation of water hydrological cycle, nutrient reserves, C and N sequestration, greenhouse gas fluxes, etc.). Changes of land use patterns are major features of urban development, and also, the main factors that result in the degradation of urban ecosystem services and global environmental problems, have become an environmental issue attracting global attention (Miheretu and Yimer, 2018). Different land use patterns not only change land cover types, e.g., surface vegetation, plant litter and residual quantity, but also directly affect soil properties and nutrient supply (Zhao et al., 2012). The decrease of forest areas has long been a global concern, most likely resulting from worry about potential poverty and loss of commodities such as foods, materials, energy sources and also services such as water filtration, soil ablation control and microclimate alignment derived from forests straightly (Trumbore et al., 2015). In the current background of climate change and its diminution, forest areas have garnered special attention for their main impress in sequestering atmosphere carbon and also nitrogen (Bellassen

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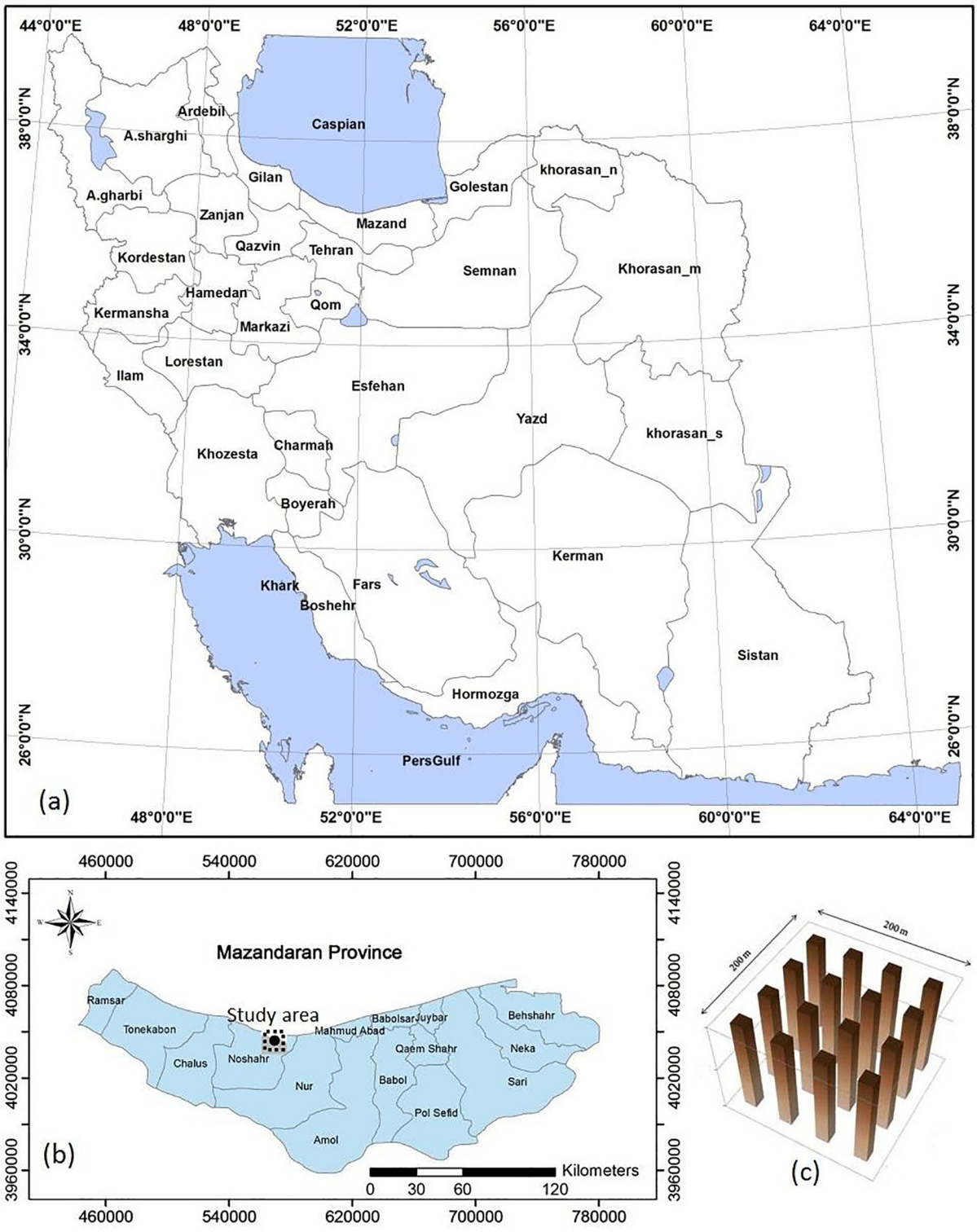

Fig. 1. Location of study area in Mazandaran Province, north of Iran (a, b) and schematic representation of the experimental design adopted for each land cover (c).

and Luyssaert, 2014). Iran is categorized under Low Forest Cover Countries (LFCC), and only 7.6% of its land is covered by forest ecosystems (IUFRO, 2004). Located at the Alborz Mountains northern slopes, the antique Hyrcanian forests are one of the most momentous ecoregion in Iran. These forests cover an area of almost 1.9 million ha extending to the southern Caspian Sea (IUFRO, 2004) and are one of the last remains of natural deciduous forests in the world (Kooch et al., 2015). Due to an increasing demand for timber, firewood, pasture, food and residential land, the forest ecosystem is being degraded or converted to rangeland or agricultural production systems at an alarming rate in most parts of Mazandaran province (Mohammadi and Shataee, 2010). This conversion of forest to other land uses or covers has created serious problems including increased soil erosion and also change in soil physical, chemical and biological properties (Oliveira et al., 2016; Adugna and Abegaz, 2016).

Soil microbes are involved in many important biochemical

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