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Combining ^{137}Cs and soil organic carbon for assessing patterns of soil formation in the rapidly changing proglacial environment of the Grey Glacier (Torres del Paine, Chilean Patagonia)

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As in other regions of the world, glaciers in South America like in Torres del Paine National Park are shrinking. The trends of increasing temperatures would accelerate melting process that will affect not only populations but also natural resources as water and soil that support life. Recent works in other polar and cold regions have shown the usefulness of combining fallout radionuclides and soil organic carbon (SOC) for tracking recent glacier retreat on glacial formations of proglacial environments. Such combination of proxies is also useful for gaining information on the creation of new soils on recently formed glacial landforms as well as to get insights on soil erosion and deposition processes in paraglacial landscapes. In this study a survey of soils and glacial deposits of an area surrounding the Grey Lake and Glacier, located in Chilean Patagonia has been undertaken in the frame of the IAEA INT5153 project. During a 15 days field campaign composite surface samples were collected on previously identified main landforms in the eastern and western margins of the Grey Glacier Lake. The study proglacial landforms include glacio-fluvial terraces, moraines, swamps, colluvial and forest slopes. The different landforms generated at different stages from Last Glacial Maximum (LMG) to Little Ice Age (LIA) and recent glacier retreat suffer the impact of climate change. At present the retreat of the Grey Glacier is highly active and entails the creation of new geomorphic elements along with active erosion and deposition processes. Analyses of ^{137}Cs, SOC and grain size along with standard soil properties were performed for characterizing the surface soil and sediment samples. The grain size of the study samples is medium coarse as indicated by the general predominance of silt and sand fractions, pH values are acidic and salinity and carbonate contents are low. The mass concentration of ^{137}Cs activity (Bq kg^{-1}) varied largely with highest mean values in soils on forest slopes (12 Bq kg^{-1}) and swamps (45 Bq kg^{-1}) in coincidence with the highest mean SOC contents of 7 and 17 % for forest slopes and swamps, respectively. On the most recently formed landforms, colluvial and glacio-fluvial terraces, the surface soils and sediments had the coarsest textures along with the lowest mean contents of SOC ($<$ 1 %) and of ^{137}Cs mass activity (2 Bq kg^{-1}), which are in accordance with more recent processes of soil formation. Fallout ^{137}Cs and SOC can provide valuable information on soil processes under rapidly changing environmental conditions occurring in the last decades in the area of the Grey Glacier Lake. Our results might help in understanding the trends in the dynamic of formation of new soils from recently exposed surfaces related to the shrinking of glaciers with rising temperatures.