Assessing the impacts of invasive alien tree species in lowland forest ecosystem in order to improve restoration strategies in Samoa

(復元計画改善を目的としたサモア低地林における侵略的外来木本種の影響評価)

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Biodiversity in the Pacific Islands has faced great threats by invasive alien species (IAS), yet most studies failed in assessing the spatio-temporal changes. The evaluation of IAS impacts is complicated and is usually perceived differently by stakeholders. Understanding species attributes in different habitats is necessary for the restoration of ecosystem structures and functions. Recently, IAS is becoming conspicuous in the forest ecosystems of Samoa. This study assessed the spatio-temporal changes in the impacts of IAS on Mount Vaea Nature Reserve in Samoa. In addition, the recovery of species diversity (resilience) after natural disturbances is investigated by analyzing normalized difference vegetation index (NDVI). Transplantation experiments were conducted by using seedlings of native species that have high growth and survival potentials.

The initial forest survey conducted in 34 transects (50 m × 10 m) in 2007 showed that 62% of stems were IAS. Three problematic species, i.e., *F. elastica*, *C. elastica* and *S. campanulata*, which accounted for 57% of total stems, impacted the most to the declining abundance, richness and diversity of native plants. IAS dominated in various strata of the forests from the floor to crown. They were ubiquitous in all size classes with *C. elastica* and *F. elastica* dominating small to medium size classes, and *S. campanulata* on large size class. *C. elastica* had the highest presence of 92% followed by *F. elastica* 77% in the site. The dispersion parameters for *C. elastica* and *F. elastica* were lower than *S. campanulata*, indicating a clustered to a random distribution. Species diversity and richness were high in less-impacted transects but low in highly-degraded transects, signifying the important roles of native species in facilitating forests dynamics. NDVI analysis showed highly-degraded sites to be susceptible to the impacts of tropical cyclones (TC), with >80% of damaged stems being IAS. The field observations confirmed that IAS tended to uproot more. The leaf area index averaged 3.1 and canopy openness averaged 11% implied a poor and vulnerable forest structure to natural calamities such as TC. After the major TC Evan that occurred in 2012, a stagnant disproportional abundance (70-90%) was recorded for IAS. Overall, IAS had transitioned from an aggregated to a contiguous distribution where native species were suppressed. In contrast, the abundance of native species remained below 25% after 2013, due probably to their slow growth. Native species also had lower basal area (median < 5000m^2). Qualitative observations on the forest floor showed native species appealing more at the seedling and sapling stages. However, native species were more tolerant to TC than IAS. Only 15% of native species were damaged in 2013, by bending and/or snapping, with less uproots. Two native species *P. samoensis* and *F. godeffroyi* out of 22 monitored tree species in the natural forest had high resilience since 2013, while five native species *R. taitensis*, *S. fanaiho*, *P. pinnata*, , *T. richii*, and *C. vitiense*, out of 12 showed high survival and growth rates in the experimental plots.

The impacts of IAS increased with time and were likely to be the strongest drivers in the declines and extinctions of native plant and animal populations. Understanding the factors affecting the establishment of IAS is crucial to develop adequate plans to reduce biological invasions, including the restoration of ecosystems. The present study showed that the threshold of concerns has been breached and a reactive adaptive management strategy is essential. In conclusion, improvement in restoration must be conducted in two steps: firstly IAS, in particular, *F. elastica*, *C. elastica* and *S. campanulata*, should be prioritized for management and reduced to below 50% abundance, focusing on the removal of mature individuals; and secondly a few native species (7 species) recommended by the experiments are to be transplanted closely in management zones.