Development of a Risk Assessment Mathematical Model for deliberate introduction of Plant Species to Sri Lanka

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Abstract

Invasive Alien Plant Species (IAPS) can be considered as a serious threat to biodiversity. Invasive potential of an animal or plant species can be recognized by their biological traits. Therefore, Risk assessment procedures for IAPS always consider biological traits that bring about the invasiveness of a species. National risk assessment in Sri Lanka is a manually conducted process conducted by a group of experts based on the data available. Due to the lack of availability of data, evaluations are often accompanied with imprecision and uncertainty. This study focused on developing a mathematical risk assessment model to evaluate risk of invasive alien plant species. Considering the data availability, 12 important factors relating to invasive potential of invasive species were chosen as the model parameters. The study was mainly focused on the dispersal traits of plants as it is a key strategy that plants use to spread their populations.

Initially dispersal related risk were modeled as it is a key strategy that plants use to spread their populations. For this task, four dispersal related risk factors were chosen and data of known 19 invasive species were gathered. For the aggregation process, fuzzy operators and fuzzy analytical hierarchy process were considered. The models were validated and those results and test results were compared with the NRA risk levels. Risk levels obtained for each species in the set of 19 species from model developed with Hamacher operator were compatible with the corresponding NRA risk (National Risk Assessment) levels and well distinguish the risk of invasive and non-invasive species such that keeping the most of non-invasive species in the very low category.

Interval multiple linear regression technique was applied to aggregate the 12 parameters. Three methods were considered to approximate the interval regression coefficients where one method was based on the work done by Chenyi Hu and other two were newly proposed. Based on those methods three models were developed and validated. The qual-

ity measurements and validation results reveal that the models based on newly proposed methods can be used to assess the risk of invasive alien species.

Next, three models were developed considering eight parameters out of 12 using fuzzy linguistic operators. The performances of the model with linguistic weighted average operator was significant though the risk levels of 25 invasive species out of 27 which used in the model development were compatible with the corresponding NRA risk levels. Also risk level of each species in the non-invasive category was placed in the low category compared to NRA levels.

To evaluate the overall invasion risk including 12 parameters a method was proposed. A novel method was used to merge the different linguistic terms set used for important weights and risk values of the parameters. Two models were developed using the proposed method based on non-weighted and weighted parameters. The model with weighted parameters were more compatible with NRA risk levels and clearly distinguished invasive and non invasive plant species.

Next, considering 2-tuple linguistic approach, two models were developed by applying the non-weighted and weighted parameters. Among the models developed concerning overall invasion risk, 2-tuple model with weighted parameters showed higher compatibility with NRA risk levels and more capable of distinguish risk of species having same linguistic labels.

The suitability of handling uncertainty using unbalanced linguistic 2-tuple approach has also been investigated. Unbalanced linguistic terms set was developed by gathering the required information. Based on the representation algorithm two models were constructed by including the non-weighted and weighted parameters. The performances of model with non weighted parameters was more capable of distinguish invasive over non invasive species than of model with weighted parameters. However,to be consistent with the NRA this model needs further improvements.

Conference Abstract:

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