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ENHANCEMENTS OF PEST RISK ANALYSIS TECHNIQUES

A manual and computerized consistent framework for assessing the vulnerability of receptor environments

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Author(s): John Mumford, Richard Baker, Johan Bremmer

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SEVENTH FRAMEWORK PROGRAMME

PROJECT OVERVIEW: PRATIQUE is an EC-funded 7th Framework research project designed to address the major challenges for pest risk analysis (PRA) in Europe. It has three principal objectives: (i) to assemble the datasets required to construct PRAs valid for the whole of the EU, (ii) to conduct multi-disciplinary research that enhances the techniques used in PRA and (iii) to provide a decision support scheme for PRA that is efficient and user-friendly. For further information please visit the project website or e-mail the project office using the details provided below:

Email: pratique@csl.gov.uk
Internet: www.pratiqueproject.eu

Authors of this report and contact details

Name: John Mumford
Partner: Imperial
E-mail: j.mumford@imperial.ac.uk

Name: Richard Baker
Partner: Fera
E-mail: richard.baker@fera.gsi.gov.uk

Name: Johan Bremmer
Partner: LEI
E-mail: Johan.Bremmer@wur.nl

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1. A Review of the Vulnerability Concept in relation to Pest Risk Analysis

The concept of vulnerability encompasses a range of properties associated with the receptor of a *specified* risk that makes either or both likelihood and/or magnitude greater (Brooks, 2003). The concept is widely discussed in the risk literature, such as that on climate change. It is sometimes divided into two broad sub-concepts that affect the relationships between agents, pathways and receptors of risk:

- Biophysical vulnerability – the propensity for an agent to cause harm to a receptor (a property of the relationship between the *agent* and *receptor*)
- Social vulnerability – human factors that reduce the ability of a *receptor* to cope with interactions with *agents* (so, in addition to the biophysical vulnerability, this could also lead to an increased likelihood and/or magnitude of loss)

A number of human factors can affect the pathway/receptor part of the risk system (so, not including the risk agent), both positively or negatively:

- Management actions, that directly favour a pest presence or damage
- Economic values, that could make impacts greater
- Diversified activities, that make it easier to accept risk
- Policy directions, that constrain management and/or markets

At some point in a pest risk assessment or in pest risk management the social factors (management, policy or values) that favour likelihood or magnitude of pest risk or affect its mitigation should be assessed. They may contribute significantly to understanding the level of risk, as well as the cause of the risk. Going beyond the scope of present pest risk assessment, this could lead to an objective assessment of future trends in risks, where there may be very dynamic cropping or market systems, for example. In addition, it may also provide some basis for determining any shared responsibility for the risk and the potential for co-responsibility in the management of the risk. This may become increasingly important as governments move to incorporate greater cost and responsibility sharing in plant health (see for example Waage et al. (2007) and the current proposed cost and responsibility sharing legislation for animal health in the UK[1]).

Vulnerability to one specified risk may make a system less vulnerable to others and this would need to be taken into account in considering responsibility.

Within a PRA there are several points about vulnerability that should/could be considered:

1) *Bio-ecological vulnerability* (equivalent of the climate risk literature term bio-physical vulnerability). This would include factors like abiotic qualities such as climate suitability, and biological qualities like host presence and presence of some level of natural enemy competition. It deals with the question: does the

[1] http://www.defra.gov.uk/foodfarm/policy/animalhealth/sharing/eip.htm

system fundamentally support establishment? This is an essential component of vulnerability. There are questions in the EPPO DSS for PRA that cover this sort of thing already (for example, 3.09 and 3.11 on hosts and climate).

2) *Management vulnerability*, which is moving from bio-ecological vulnerability toward the issue of social vulnerability, but without a value judgement. Is the agro-ecosystem managed in a way that makes it vulnerable to the pest, in addition to being intrinsically vulnerable? This could be established in a PRA through questions about rotation, monoculture, timing, cultivation, etc, which would expand on questions such as the present EPPO scheme question 3.15 “How likely is the pest to establish despite existing pest management practice?” The intent of such questions would be neutral, simply establishing that there are management practices that would favour or not favour entry, establishment, spread, or impact.

3) *Social vulnerability*, in the fullest sense of social choices being made that actively contribute to vulnerability (is likelihood greater, is magnitude greater?). So it would be necessary to determine whether there is a reasonable alternative management that would make the agro-ecosystem less vulnerable to establishment. The assessment would need to determine why there is monoculture, no rotation, late planting, no cultivation, etc that might in particular cases favour or not favour establishment? Are farmers choosing to manage in a way that favours the pest when they could do something else? Are government policies or market forces pushing particular management that favours a pest, and are there alternatives? Have markets been manipulated to create higher prices for the product that artificially inflates the potential impact of a pest? This opens up further issues, such as what other risks would be greater if different management, policies, etc were in practice?

Bio-ecological vulnerability deals simply with natural factors that contribute to risk (likelihood and/or magnitude); management vulnerability deals with management that contributes to risk, but without attaching any responsibility to it; and social vulnerability tries to determine if there is some social responsibility (which might in the extreme be considered "blame") for putting the system at risk.

Within a PRA scheme additional questions related to social vulnerability could occur in either assessment or management, and this demonstrates the difficulty in distinguishing these two stages fully. In an assessment, where a management practice is identified as contributing to pest risk then additional questions could determine if there is a reasonable alternative to that management and ideally to try and determine why that management is being done (for example, ignorance, convenience, public policy, market pressure, etc). This would help to determine the contribution of social vulnerability to the overall risk assessment and its cause, which could be important in making management decisions - what to do, who should do it, and maybe even who should share the cost? However, these questions could also be posed within the pest risk management stage of a PRA. The stage at which the determination of social vulnerability is carried out should be decided by the efficiency of gathering the information rather than on a purely philosophical basis of rigid separation of assessment and management. Ideally, a PRA process would have adequate links between assessment and management to ensure that this information could be captured in either stage.

PRAs should be able to distinguish vulnerability that arises because a potential pest has an intrinsic relationship with an environment that favours its establishment and the vulnerability that arises because some thousands of people choose to grow a crop in a way that encourages that establishment. Naturally there may be quite a lot of argument about the responsibility issue this raises, which indicates the need for an objective system, such as pest risk assessment, to identify and possibly apportion that responsibility. Stakeholder involvement in the process would be needed to help establish causes of social vulnerability and the degree of flexibility in management that may be feasible.

The concept of vulnerability has been addressed in part by the CBD (2001) and they make some general points about vulnerability. Alien plants and animals are spreading in protected areas of various types in nearly all parts of the world. Some types of ecosystems are more vulnerable to invasions than others. Invasive alien species usually thrive in disturbed habitats. Invasive alien species are especially acute in isolated systems such as islands and other isolated areas such as lakes and isolated streams. Species rich ecosystems can be susceptible to a wider range of species because they have a greater diversity subject to the impact of invasive species. Low diversity ecosystems such as deserts; those that are subject to periodic disturbances, harbours, lagoons, estuaries, areas undergoing successional changes, and edges of water bodies have also been observed to be more prone to invasions. These observations give a general sense of bio-ecological vulnerability, but do not address issues related to management or social vulnerability.

Kareiva and Quinlan (2002) proposed a novel approach that would include a broad vulnerability value of the recipient region when deciding on prevention. By implication, this would be in the management stage of a PRA. They noted that the concept of vulnerability is a common element in environmental impact assessment, but that it is usually limited in Pest Risk Analysis to a review of bio-ecological vulnerability due to climatic conditions and hosts or management vulnerability due to susceptible agricultural systems, as can be seen in the present EPPO PRA scheme. Impact of drought, pollution, new species, isolation or other disrupting forces that make a community particularly vulnerable to invasion are left out of present PRA schemes. They approached the concept of social vulnerability by pointing out that special protection for more vulnerable plants or communities is analogous to a principle of medical risk analysis in which children are afforded an extra degree of precaution, due to their vulnerability and the values associated with responsibility for dependent members of society such as children.

In conclusion, bio-ecological and management vulnerability are already included in most PRA schemes, including the EPPO PRA scheme. However, social vulnerability is a key issue in relation to assessing both the level of pest risk and establishing a basis for co-responsibility in risk management. Vulnerability assessment would help to determine what management or policy factors contribute to susceptibility to risk (likelihood or impact) and how these should be taken into account in assigning responsibility for management.

2. The Approach taken by PRATIQUE

As noted above, bio-ecological and management types of vulnerability are already included in most PRA schemes and this is also true of the EPPO DSS for PRA. As such, the addition of these vulnerability concepts within the DSS for PRA has not been attempted. The wider concept of social vulnerability related to management options is not considered in the risk assessment component of PRAs and is not included in ISPM11 (FAO, 2004) and so has not been studied by PRATIQUE. Potential results of a social vulnerability assessment of receptor environments cannot be used in PRA based decision making. Therefore the development of a separate computerized consistent framework for assessing the vulnerability of receptor environment has not been undertaken.

However, the ranking of economic, environmental and social receptors in terms of vulnerability or, more loosely, in terms of higher risk is undertaken in one part of the EPPO DSS for PRA (question 6.15) where assessors are asked to identify the endangered area. The endangered area is defined as: “the part of the PRA area where the presence of the pest will result in economically[2] important loss”. Here assessors thus have to look at the different receptors (host crops, host plants, habitats and ecosystems), identify which are at highest risk and locate where the pest presence will result in “economically important loss.”

Since this is related directly to risk mapping, the identification of receptors that are at most vulnerable (at higher risk) has been undertaken in Deliverable 3.3 (the protocol for mapping endangered areas taking climate, climate change, biotic and abiotic factors, land use and economic impacts into account). This approach is outlined below.

3. Identifying the economic, environmental and social receptors that are most vulnerable (at highest risk)

In Stage B1 of Deliverable 3.3 the key factors that influence the endangered area are identified and in Stage B2, where data are available and as appropriate, these factors are combined to identify the areas where the receptors are at highest risk.

Although not defined as such, a detailed description of how to model and the bio-ecological vulnerability factors (climate, host distribution, abiotic factors etc) is described in detail in the protocol for mapping endangered areas.

Management vulnerability factors are also not defined as such in the protocol but they are divided into three categories related to economic, environmental and social impacts as follows:

Factors that put crops at highest risk from economic impacts include:

[2] Environmental and social impacts are also included in economic impacts, following Supplement 2 of ISPM5 (FAO, 2010)

- Pest friendly management practices, e.g. no rotation for *Diabrotica virgifera virgifera*
- Especially high value, e.g. seed potatoes, salad crops in heated glasshouses
- Very high quality standards, e.g. dessert fruit
- Long replacement time, e.g. timber & fruit trees
- Significant proportion of national production including a lack of suitable alternative crops
- Significant proportion of the export market
- Heritage varieties
- importance of the crop at risk in a crop rotation

Factors that put uncultivated species, habitats and ecosystems at highest risk from environmental impacts include:

- “Keystone”, indicator species
- Protected, rare and endemic species
- Special areas of conservation (e.g. Natura 2000 (EEA, 2011)) and other nature reserves
- Islands and other isolated habitats
- Habitats most often invaded (Chytrý et al. 2008a,b; Pyšek et al. 2009)
- Fragile ecosystems, e.g. sand dunes, that are not resilient to species loss
- Species, habitats and ecosystems providing important services

Factors that put the human population at highest risk from social impacts include:

- Risks to human health
- The local economy of an area is dependent on the species at risk (i.e. alternative sources of employment are limited)
- The cultural significance of the threatened species
- Areas of high amenity value

The DSS for selecting and combining these factors to identify receptors and map areas at highest risk (greatest vulnerability) is illustrated by two examples: the western corn rootworm, *Diabrotica virgifera virgifera,* and the water hyacinth, *Eichhornia crassipes*.

However, mapping is limited by data availability and it may not be possible to map many of the factors listed above, especially, as in PRATIQUE, when we are attempting to map the areas at highest risk for all countries in the EU. In D3.3, for *D. virgifera virgifera*, we have been able to map climatic suitability, host distribution (grain and forage maize), host yield, crop value and soils that influence impact but were not able to produce maps for the whole of the EU that show where maize is grown without rotation. In the EU, it has been shown that without rotation, pest population densities markedly increase enhancing the likelihood that significant economic impacts will occur (EPPO, 2003). Since *D. virgifera virgifera* is essentially a crop pest, only economic impacts are generally considered and the host with the highest risk and greatest vulnerability is grain maize in areas where it is very commonly grown, has the greatest yield, is not grown on sandy soils, is not rotated and is very suitable climatically for the pest. Since maize is also grown for game cover (to protect young birds that will subsequently be shot from predators) in the United Kingdom, the pest could also have a potential social impact, however, current climatic conditions are not considered to be sufficiently suitable to allow *D. virgifera virgifera* population densities to reach damaging levels (Baker *et al*., 2003).

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