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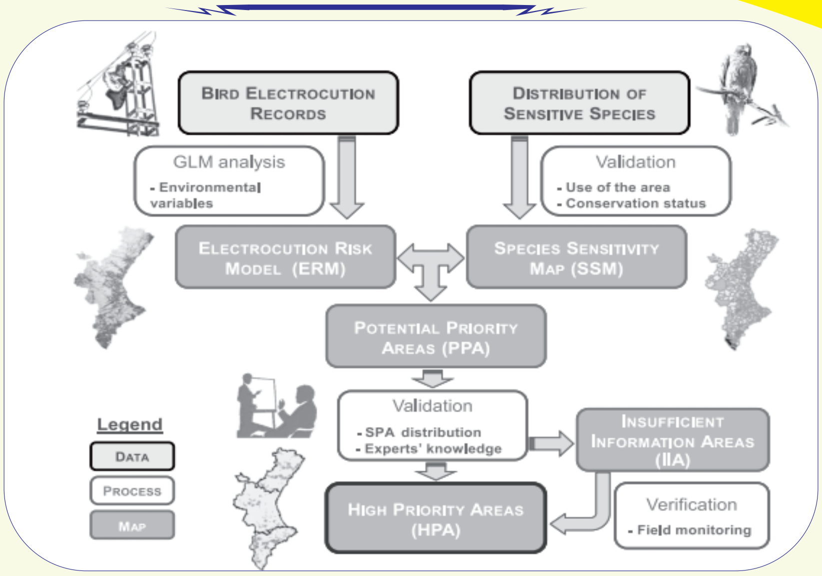


WHAT'S INSIDE

सत्यमेव जयते
Department of Agriculture, Cooperation & Farmers Welfare
Ministry of Agriculture and Farmers Welfare, Govt. of India

From the Director General's Desk

The Covid pandemic has affected all the activities of the world, the Institute not differing in the aspect. However, being committed to upliftment of the farmers, the backbone of our country, Institute started online training programmes from June 2020. All respective divisions have been instructed to conduct regular online training programmes in topics which are feasible to be conducted. Further, many webinars have been planned to disseminate information quickly.

The United Nations has declared 2020 as the International Year of Plant Health (IYPH). The year is a once in a lifetime opportunity to raise global awareness on how protecting plant health can help end hunger, reduce poverty, protect the environment, and boost economic development. On the occasion of International Year of Plant Health (IYPH) this year, NIPHM is organizing a webinar series comprising of various plant health management issues. It is expected that the series will be platform for many experts to assemble and deliberate various issues related to plant health management.

Institute took all possible care for keeping the staff and premises away from the pandemic issues. Various health care activities, including regular sanitization and all possible preventive measures were adopted in the Institute as per guidelines from Ministry of Health, GoI. The institute was back in action from May 2020 and now conducting regular activities through dedicated staff. We have continued the sample analysis and production of bio fertilizers also and regularly supplying the same to needy farmers and other stake holders.

NIPHM is marching stern amidst the pandemic. We hope and pray to come out safe of this pandemic and continue our activities more vigorously for the benefit of the farming population of the country.

कोविड महामारी ने दुनिया की सभी गतिविधियों को प्रभावित किया है और यह संस्थान भी इस महामारी से अछूता नहीं रहा है । किसान हमारे देश की रीढ़ है । इसलिए, उनके उत्थान के लिए प्रतिबद्ध होकर, संस्थान ने जून, २०२० से ऑन लाइन प्रशिक्षण शुरू किया है । सभी संबंधित प्रभागों को निर्देश दिया गया है कि वे उन विषयों में नियमित रूप से ऑनलाइन प्रशिक्षण कार्यक्रम संचालित करें, जिन्हें आयोजित किया जाना संभव है । इसके अलावा, शीघ्रता से सूचना प्रसारित करने के लिए कई वेबिनार योजना बनायी गई है।

संयुक्त राष्ट्र ने वर्ष २०२० को अंतर्राष्ट्रीय वनस्पति स्वास्थ्य वर्ष (आईवाईपीएच) के रूप में घोषित किया है। वैश्विक जागरूकता को बढ़ावा देने के लिए कि कैसे पौधों की स्वास्थ्य की रक्षा भूखमरी को समाप्त करने, गरीबी को कम करने, पर्यावरण की रक्षा करने और आर्थिक विकास को बढ़ावा देने में सहायता करती है । इस वर्ष अंतराष्ट्रीय वनस्पति स्वास्थ्य वर्ष के अवसर पर, एनआईपीएचएम वेबिनार के माध्यम से विभिन्न वनस्पति स्वास्थ्य प्रबंधन संबंधी मूद्दों पर प्रशिक्षण कार्यक्रमों का आयोजन कर रहा है । यह उम्मीद की जाती है कि श्रृंखला कई विशेषज्ञों को वनस्पति स्वास्थ्य प्रबंधन से संबंधित विभिन्न मुद्दों पर विचार-विमर्श के लिए मंच होगी ।

संस्थान ने कर्मचारियों की देखरेख हेतु हर संभव प्रयास किया एवं परिसरों को महामारी संबंधी समस्याओं को दूर रखा । स्वास्थ्य मंत्रालय, भारत सरकार के दिशा-निर्देशों के अनुसार संस्थान में नियमित तौर साफ-सफाई एवं रोकथाम संबंधी सभी उपायों सहित विभिन्न स्वास्थ्य देखभाल गतिविधियों को अपनाया गया। संस्थान ने मई 2020 से अपनी क्रियाकलापों को शुरू कर दिया एवं अब कर्मठ कर्मचारियों के माध्यम से नियमित गतिविधियों का संचालन किया जा रहा है । हमने जैव उर्वरकों के नमूना विश्लेषण और उत्पादन को भी जारी रखा है और जरूरतमंद किसानों और अन्य हितधारकों को नियमित रूप से आपूर्ति की जा रही है ।

महामारी में एनआईपीएचएम क्रियाकलापों का निष्पादन कर रहा है । हम आशा एवं प्रार्थना करते हैं कि इस महामारी से हम सुरक्षित बाहर निकलगें एवं देश के किसानों एवं कृषि के हित के लिए और कठोर परिश्रम से अपनी गतिविधियों को जारी रखेंगे ।

(G. Jayalakshmi, IAS)
Director General

Sensitivity Analysis of Crop Water Footprint

Vidhu Kampurath P, Udayabhanu M, Govind Kumar Maurya, Venkata Hemanth and B. Madhavi

Sensitivity Analysis investigates how the variation in the output of a numerical model can be attributed to variations of its input factors. This paper presents the review, in a complete methodological framework, of various sensitivity analysis methods used to obtain model output. Numerous statistical and probabilistic tools (regression, smoothing, tests, and statistical learning.) that aim at determining the model input variables which mostly contribute to an interest quantity depending on model output. The quantity can be for instance of variation in output variable. Three kinds of methods are explained, the screening, the measures of importance and the deep exploration of the model behavior. A synthesis is given to place every method according to several axes, mainly the cost in number of model evaluations, the model complexity and the nature of brought information

Sensitivity Analysis:

In many fields such as environmental risk assessment, behavior of agronomic systems, structural reliability or operational safety, mathematical models are used for simulation, when experiments are too expensive or impracticable, and for prediction. Models are also used for uncertainty quantification and sensitivity analysis studies. Complex computer models calculate several output values that can depend on a high number of input parameters and physical variables. Some of these input parameters and variables may be unknown, unspecified or defined with a large imprecision range. Inputs include engineering or operating variables, variables that described conditions, and variables that include unknown or partially known model parameters. In this, the investigation of computer code experiments remains an important challenge. This computer code exploration process is the main purpose of the Sensitivity Analysis process. Sensitivity analysis allows the study of how uncertainty in the output of a model can be apportioned to different sources of uncertainty in the model input (Ksenia Brazhnik et al., 2015). It may be used to determine the input variables that contribute the most to an output behavior, and the non-inertial inputs, or to ascertain some interaction effects within the model.

A methodology for conducting a sensitivity analysis is a well established requirement of any scientific discipline. A sensitivity and stability analysis should be an integral part of any solution methodology. The status of a solution cannot be understood without such information. (Suseela et al.,2012). Even the papers with a focus on applied methodology have tended to concentrate on systems and procedures which are relatively time consuming and complex to implement. There has been almost large procedures and methodological issues for simple approaches to sensitivity analysis. (Eschenbach and Fanny et al., 2012).

The objectives of sensitivity analysis are numerous one can mention model verification and understanding, model simplifying and factor prioritization. Finally, the sensitive analysis is an aid in the validation of a computer code, guidance research efforts, or the justification in terms of system design safety. There are many application examples, for instance by (Makowski, D. Makowski, Filip,2011) analyze, for a crop model prediction, the contribution of 13 genetic parameters on the variance of two outputs. Another example is given where it aim of sensitivity analysis is to determine the most influential input among a large number, for an aircraft infrared signature simulation model. The first historical approach to sensitivity analysis is known as the local approach. The impact of small input perturbations on the model output is studied, these small perturbations occur around nominal values. This deterministic approach consists **in** calculating or estimating the partial derivatives of the model at a specific point. The use of adjoint-based methods allows to process models with a large number of input variables, Such approaches are commonly used in solving large environmental systems as in climate modeling, oceanography, hydrology, etc. (Juan ,Cacuci,2010) identify and prioritize the most influential inputs, identify non-influential inputs in order to fix them to nominal values.

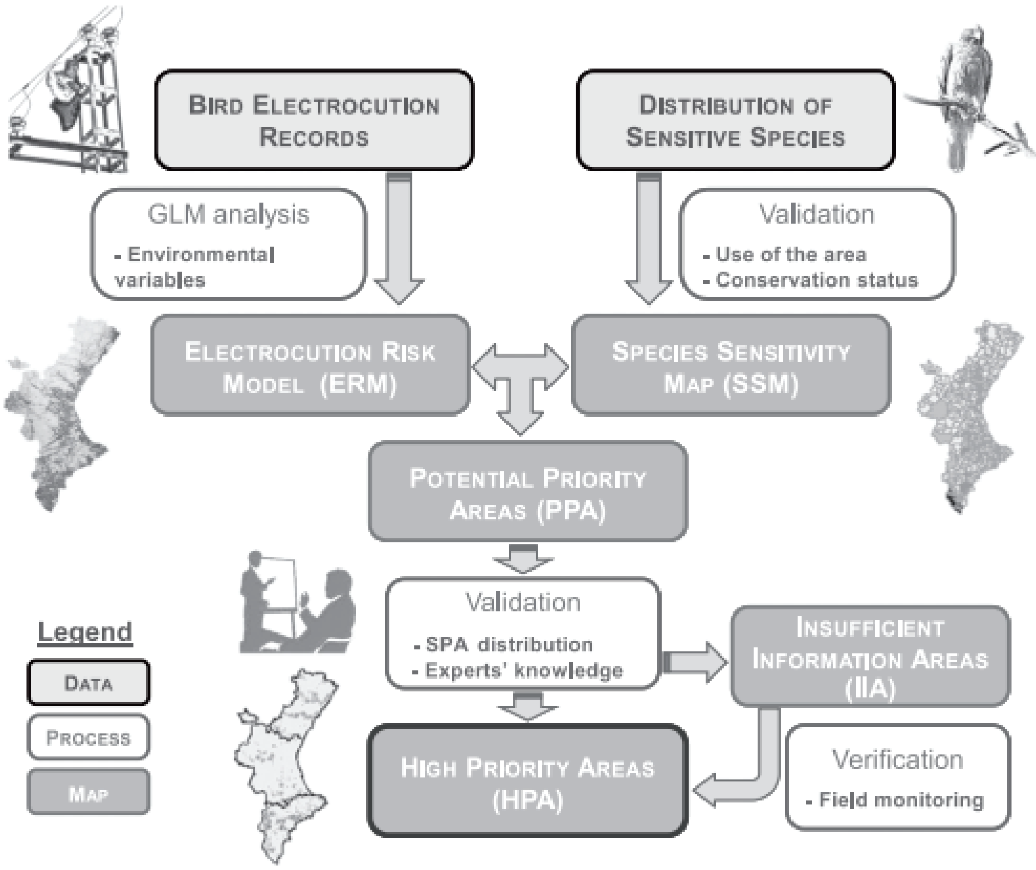


Fig. Diagram of the identification process for high priority areas for bird protection from electrocution on power lines in the Valencia Region (Eastern Spain)

Sensitivity analysis applications may consider model parameters but also other input factors of the simulation procedure, for instance the model's forcing data (Hamm et al., 2006) its spatial resolution simultaneously. Different types of sensitivity indices can be used, ranging from correlation measures between inputs and output to statistical properties of the output distribution, its variance, and many others. Since analytical computation of these indices is impossible for most models, sensitivity indices are usually approximated from a sample of inputs and output evaluations. Global sensitivity analysis is used for a range of very diverse purposes, including: to support model calibration, verification, diagnostic evaluation or simplification (Sieber and Uhlenbrook, 2005) to prioritize efforts for uncertainty reduction, to analyse the dominant controls of a system and to support robust decision-making (Singh et al. 2004).

Uses of sensitivity analysis

There is a very wide range of uses to which sensitivity analysis is output. The uses are grouped into four main categories, decision making or development of recommendations for decision makers, communication, increased understanding or quantification of the system, and model development. While all these uses are potentially important, the primary focus of this paper is on making decisions or recommendations many techniques and procedures have been discussed, ranging from simple to complex.

The Novel data analysis methodology for determining the approximate location of a leak burst within a district metered area. The methodology is based on Statistical Process Control and it is encapsulated in a Leakage Location System that automatically processes the night-time data recorded, with a one minute frequency, by the DMA's pressure loggers. The LLS was field tested and verified on a large number of real-life DMAs with both real and engineered leak burst events (Jochen et al.,2017). The results obtained also illustrate that the LLS has the potential to enable water companies to improve customer service through more proactive and informed communications and reduction of the number/duration of supply interruptions and poor pressure situations, realize a wide range of sustainability and environmental type benefits by saving large amounts of water, reducing energy requirements for pumping, consumption of chemicals for water treatment. In one article they have give the uses of sensitivity analysis are decision making or development of recommendations for decision makers, identifying critical values, thresholds or break-even values where the optimal strategy changes, identifying sensitive or important variables, Developing flexible recommendations which depend on circumstances, Assessing the riskiness of a strategy or scenario, Making recommendations more credible, understandable, compelling or persuasive, Allowing decision makers to select assumptions, Conveying lack of commitment to any single strategy, Estimating relationships between input and output variables, Understanding relationships between input and output variables, Testing the model for validity or accuracy, Searching for errors in the model, Simplifying the model. Calibrating the model, Coping with poor or missing data and Prioritizing acquisition of information (Erin et al.,2013).

The author (Goyal et al.,2004) explained about the global warming due to greenhouse effect is expected to cause major changes in climate of some areas. The Penman–Monteith equation was used to estimate reference evapotranspiration, and sensitivity of ET has been studied in terms of change in temperature, solar radiation, wind speed and vapor pressure within a possible range of 20% from the normal long-term meteorological parameters. The study suggests an increase of 14.8% of total ET demand with increase in temperature by 20%. ET is less sensitive to increase in net solar radiation, followed by wind speed in comparison to temperature. Increase in vapor pressure has a small negative effect on ET. A 10% increase in temperature and actual vapor pressure coupled with 10% decrease in net solar radiation could result even in marginal decrease of total ET.

Theoretical Framework for Using Sensitivity Analysis for Decision Making

Sampling based methods are described in Weights and Importance in Composite Indicators written by (Saltelli,2015) shows how, from an initial sample of input and output values, quantitative sensitivity indices can be obtained by various methods like correlation, multiple linear regression, non-parametric regression and applied in analyzing composite indicators. In Variance-based Sensitivity Analysis theory and estimation algorithms, written by (Kendall and Stefano Tarantola,2014). The definitions of the variance-based importance measures and the algorithms to calculate them will be detailed. In Derivative based Global Sensitivity Measures, written by (Kucherenko and Bertrand, 2014), the global sensitivity analysis based on derivatives sample SEBS indices are explained, while in Three complementary methods for sensitivity analysis of a water quality model written by (Sun X. Y.2012), the moment independent and reliability importance measures are described. Third, in depth exploration of model behavior with respect to inputs variation can be carried out. In Meta model-based Sensitivity Analysis includes recent advances made in the modeling of computer experiments. A meta model is used as a surrogate model of the computer model with any sensitivity analysis techniques, when the computer model is too CPU time consuming to allow a sufficient number of model calculations. Special attention is paid to two of the most popular meta models, the polynomial chaos expansion and the Gaussian process model, for which the Sobol' indices can be efficiently obtained. Finally, Sensitivity Analysis of Spatial and or Temporal Phenomena, extends the sensitivity analysis tools in the context of temporal and or spatial phenomena.

The inverse identification of the parameters of a nonlinear material model using an optimization algorithm, it is advantageous to utilize sensitivity analysis as a pre processing tool to decrease the dimensions of the design vector by removing insignificant parameters (Filip et al.,2008). It is possible to derive special forms of objective functions for better understanding of the functionality of the given complex material model. The regional climate model HIRHAM was compared to the evaporation given by the regional climate model GWB for selected point. Important evaporation process and how they are represented in the two model with monthly and annual average value were compared. Both model overestimated the average annual evaporation compared to observation at three sites. HIRHAM estimate in winter season whereas GWB in spring and autumn evaporation. Both models indicate the largest increase in evaporation will be in the spring and autumn but in summer season evaporation will decrease in many location (Kolbjorn et al .2004).

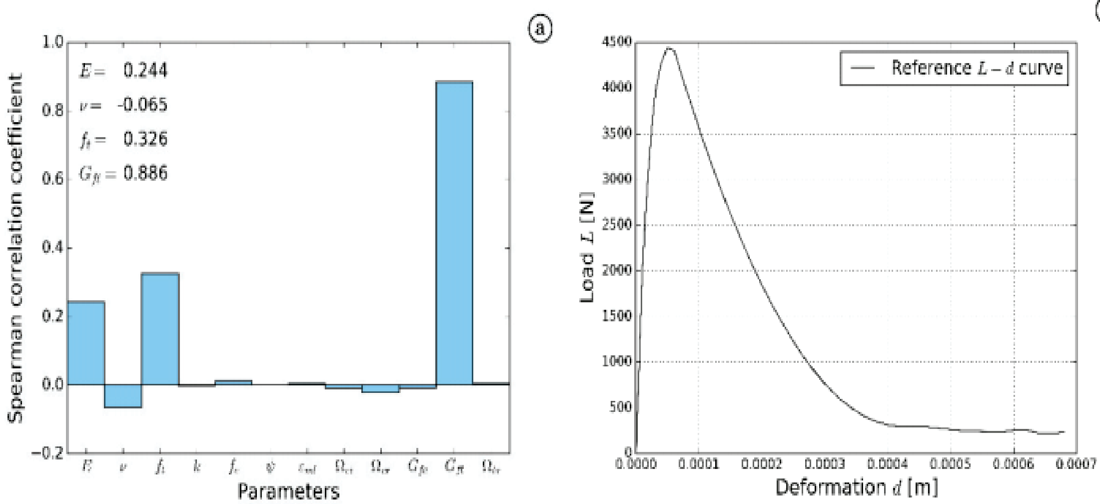


Fig. (a) A sensitivity bar chart ± the single RMSE measure; (b) the experimental L-d curve

The soil vegetation atmosphere transfer (SVAT) schemes use increasingly complex descriptions of the physical mechanisms governing evapotranspiration fluxes, there by requiring the specification of a large number of parameters controlling the fluxes over a single homogeneous area, recent attention towards the incorporation of sub grid scale spatial variability in SVAT parameterizations promises to increase the number of parameters for these models (Franks.,1997). The analysis of uncertainties reveals that are larger than those anticipated by the model developers. Econometrician in discussing this argues that, the reason these methods are rarely used is their honesty seems destructive. In the negative consequences of doing sensitivity analysis are discussed. On the basis of large sensitivity of the estimates upon the discount factors employed. Sterns own sensitivity analysis, revealed according to the authors in (Hombres et al.,,1996) that while the discount factors were not the only important factors determining the cost estimate, the estimates were indeed very uncertain

The objective functions, which are measures of model performance calculated by comparison of modeled and observed variables. It is possible to fit a linear model explaining the behavior of Y given the values of X, provided that the sample size n is sufficiently large. Some global sensitivity measures defined through the study of the fitted model (Yeshewatesfa et al.,2004)are presented in the following, Main indices are

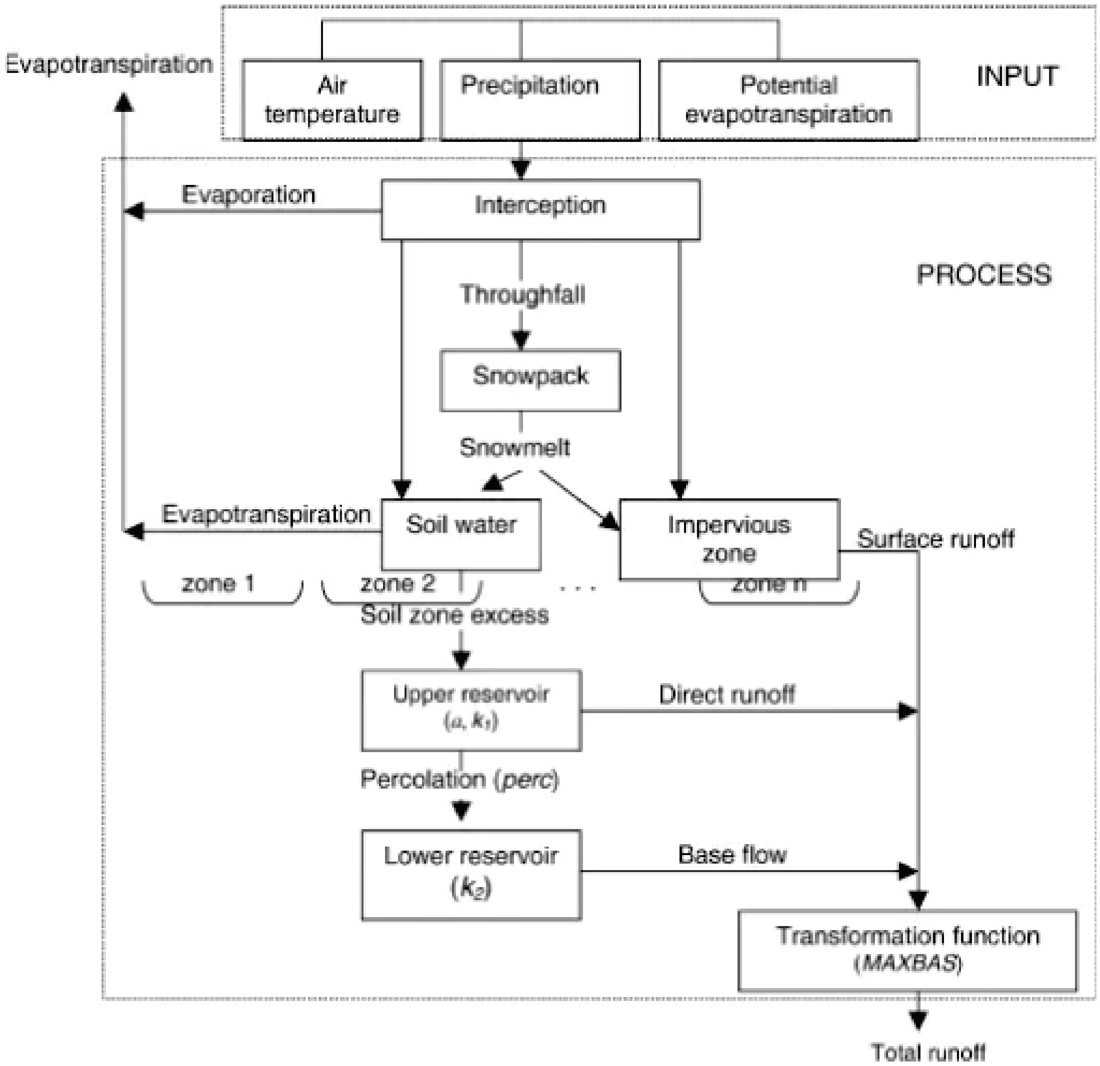


Fig. Schematic representation of the structure of the HBV-IWS model

Root-mean-square deviation (RMSD) or Root-mean-square error (RMSE) is a frequently used measure of the difference between values (sample and population values) predicted by a model (or) an estimator and the values actually observed.

$$RMSE=\sqrt{\frac{\sum_{i=1}^{n}(Qabs-Qprd)}{n}}$$

Root-mean-square deviation (RMSD) or Root-mean-square error (RMSE) is a frequently used measure of the difference between values (sample and population values) predicted by a model (or) an estimator and the values actually observed.

$$BIAS=abs\left(\frac{1}{n}\left(\sum_{i=1}^{n}(Qabs-Qprd)\right)\right)$$

R^2 It is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determinate, or the coefficient of multiple determinations for multiple regressions.

$$R^2=1-\frac{\sum_{i=1}^{n}(Q\,obs-Q\,prd)^2}{\sum_{i=1}^{n}(Q\,obs-\bar{Q}\,prd)^2}$$

In statistics, the coefficient of determination is a number that indicates the proportion of the variance in dependent variables that is predictable from the independent variable.

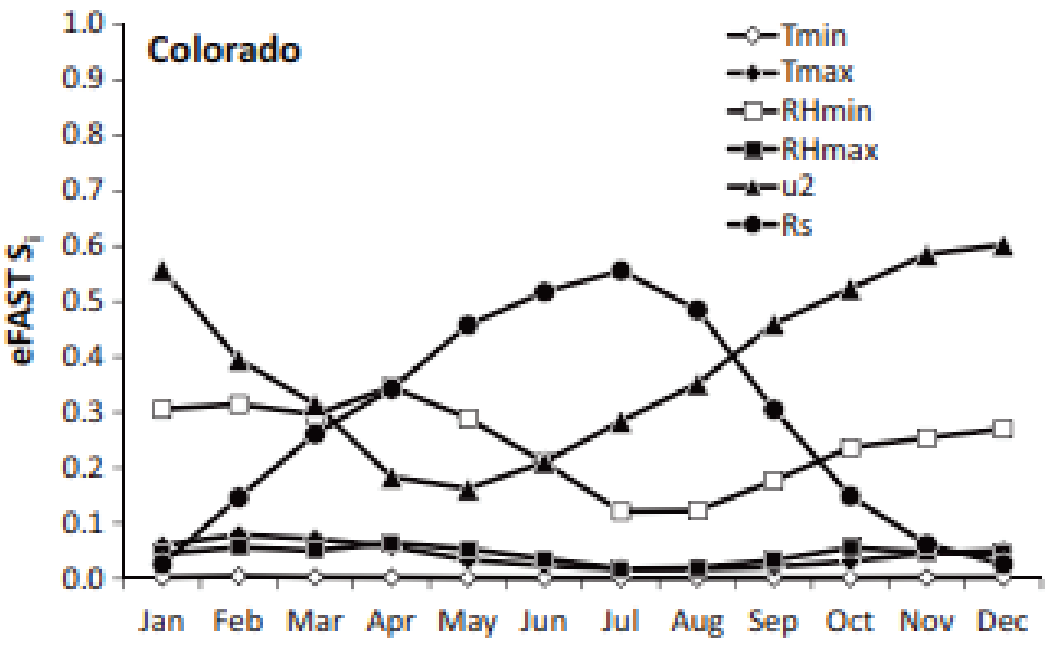
One-at-a-Time Sensitivity analysis

This type of sensitivity analysis only uses parameter sensitivity, relative to the point estimates chosen for the parameters held constant. One at a time test was conducted where the sensitivity measure was determined by adjusting parameter values by a percentage of their base value. The sensitivity measure was determined by calculating the ratio of model results while the input parameter was varied by ±20%. A more powerful test of local sensitivity examines the changes in output as each parameter is individually increased by a factor of its standard deviation (±SD). This type of sensitivity measure takes into account the parameters variability and the associated influence on model output.

The most engineering used screening method is based on the One at a Time (OAT) design, where each input is varied while fixing the others. When the number of experiments is of the same order than the number of inputs, the classical theory of experimental design applied for the factorial fractional design. The method of Morris allows classifying the inputs in three groups. They are inputs having negligible effects, inputs having large linear effects without interactions and inputs having large non-linear or interaction effects. The method consists of decrease in the input for each variable, then performing the OAT design. Such designs of experiments are randomly chosen in the input space, and the variation direction is also random. The repetition of these steps allows the estimation of elementary effects for each input. From these effects, sensitivity indices are derived.

Social sensitivity analysis is aimed on exploring the robustness of complex governance processes through the involvement of stakeholders. This approach is based on the concepts of transparency and citizen participation. These communities are also known as a stakeholder community, are allowed to evaluate the quality of planning processes and give their opinion on the results (Serafin et al.,2017). The other author (Francesca,2015) explained the methods that consider the entire Probability Density Function of the model output, rather than its variance only, are preferable in cases where variance is not an adequate proxy of uncertainty. When the output distribution is highly-skewed or when it is multi-modal. Still, the adoption of density based methods has been limited so far, possibly because they are relatively more difficult to implement. Here we present a novel GSA method, called PAWN, to efficiently compute density-based sensitivity indices. The key idea is to summarize output distributions by their Cumulative Distribution Functions, which are easier to derive than PDFs.

In this paper the authors discussed the impact of different likelihood functions in identifying sensitive parameters of the highly parameterized, spatially distributed Soil and Water Assessment Tool (SWAT) watershed model for multiple variables at multiple sites. The global one-factor-at-a-time (OAT) method of Morris was used for sensitivity analysis of stream flow, combined nitrate and nitrite fluxes, and total phosphorous at five gage stations in a primarily agricultural watershed in the Midwestern United States. The Morris method was analyzed for 36 combinations of informal likelihood functions, gage stations, and SWAT model output responses, including relative error mass balance, Nash–Sutcliffe efficiency coefficient, and root mean square error for peak and low fluxes, and one formal likelihood function that aggregates information content from multiple sites and multiple variables using SWAT parameters (Mehdi et al.,2014).



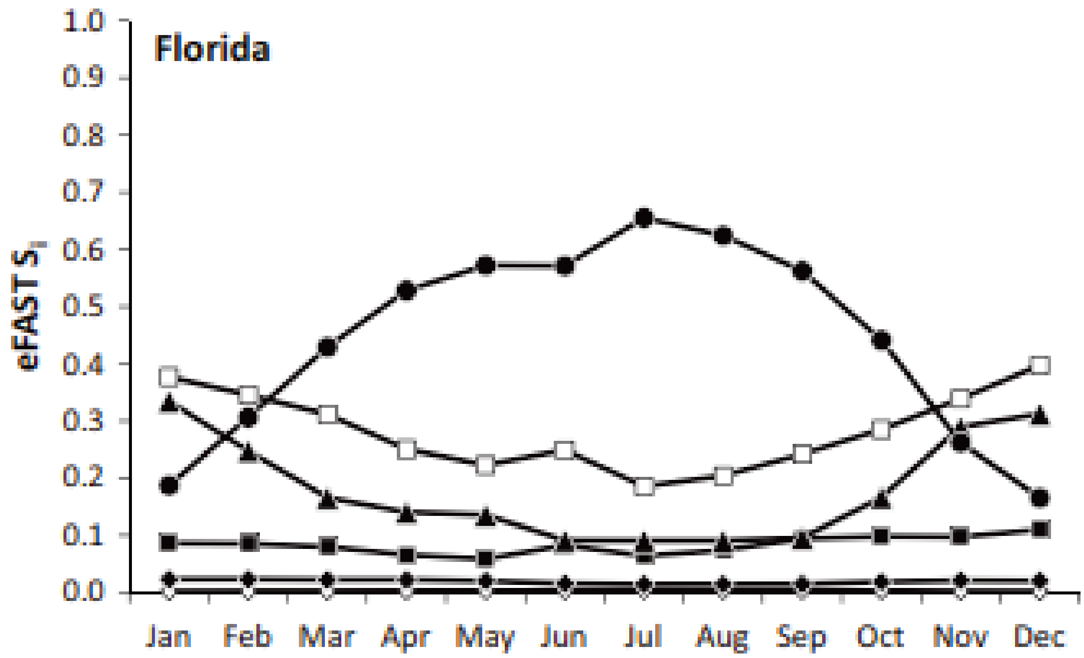


Fig. eFAST GSA Si (1st order sensitivity) results for Colorado (above) and Florida (below) averaged by month, assuming accuracy limits of the ideal sensor set

The purpose of sensitivity analysis defines the ultimate goal of the analysis. It therefore guides the choice of the appropriate sensitivity analysis method since different methods are better suited to address different questions. Although sensitivity analysis is most commonly used for the three purposes above, our list is not exhaustive and other sensitivity analysis settings have been proposed. For instant the direction of change is a question that can be addressed by sensitivity analysis (Anderson et al.,2014). They aim to evaluate the sensitivity of nine key parameters when predicting live aboveground biomass with the widely used FLM, LANDIS-II. To fully explore parameter interactions and nonlinear model behavior, we selected a range of parameter values based on LANDIS-II applications in North America that was considerably wider than in previous local sensitivity analyses. Our results showed common laities with previous studies, which concluded the maximum allowable biomass and maximum annual net primary productivity specified for a species were most influential when predicting AGB (Erin et al.,2013).

The most widely used methods for sensitivity analysis are the deterministic methods as the local sensitivity analysis, the experimental design strategies, the sampling-based and variance-based methods developed from the 1980s and the new importance measures and meta model based techniques established and studied since the 2000s. Moreover, in this the non-probabilistic representation of uncertainty, a small amount of sensitivity analysis methods has been developed. For instant, to estimate the total Sobol indices at low cost remain a problem of primary importance in many applications for a recent review on the subject. The second order Sobol indices estimations have recently been considered by (Fruth et al and Tissot and Prieur.2011). The work offers a powerful estimation method because the number of model calls is independent of the number of inputs. However, for high-dimensional models, estimation basis and computational costs remain considerable.

From an independent and identically distributed sample, other techniques can be used for sensitivity analysis. For example, statistical testing based techniques consist, for each input, to divide the sample into several sub samples. Statistical tests can then be applied to measure the homogeneity of populations between classes common means based on a Fisher test, common median based one at a time test, common variances based on a Fisher test, common locations based on the Kruskal-Wallis test. These methods do not require assumptions about the monotony of the output with respect to the inputs but lacks of some quantitative interpretation. The indices are based on the second order moment of the output distribution. In some cases, variance poorly represents the variability of the distribution

A sensitivity index is a number calculated by a defined procedure which gives information about the relative sensitivity of results to different parameters of the model. An example of a sensitivity index is the elasticity of a variable with respect to a parameter. The higher the elasticity, the higher the sensitivity of results to changes in that parameter. (Hameby et al., 1994) studied the possible sensitivity indices for cases where only a single output variable is to be evaluated, including the importance index, the relative deviation index, the partial rank correlation coefficient, the Smirnov test, the Cramervon Mises test, and a number of others. Later (Hameby et al., 1994) conducted a detailed comparison of the performance of each of the indices relative to a composite index based on them. Alexander (1989) suggested a number of complex indices for use in situations where the modeler wishes to assess the sensitivity of several output variables simultaneously.

Sensitivity analysis in water footprint

The global freshwater demand will increase to meet the growing demand for food, fibre and biofuel crops. Raising water productivity in agriculture, that is reducing the water footprint per unit of production, will contribute to reducing the pressure on the limited global freshwater resources. This study establishes a set of global WF benchmark values for a large number of crops grown in the world. The study distinguishes between benchmarks for the green blue water footprint and the grey water footprint (Mesfin et al.,2014). Hydrologically based, multi-year daily crop model called PolyCrop, and tested it for the purpose of reproducing the dynamics of maize within two case .In this case model used daily information of weather drivers given by temperature, precipitation, and solar radiation to simulate soil water budget, crop growth and crop yield, providing daily estimates of soil moisture, evapotranspiration, leaf area index LAI, and biomass. compared actual evapotranspiration, and soil moisture against daily field measurements taken by an eddy covariance tower, and TDR probes, biomass against results from simulations with CS and LAI against estimates from MODIS satellite images at 1 km resolution with eight-day frequency of acquisition. We then calculated water footprint of maize in the area, defined as the absolute and specific amount of water evapotranspired during the growing season, and we use PC and CS models to assess WFG, and WFB, under the present irrigation scheme (Nana et al.,2014).

The water footprint is an indicator of freshwater use taking into account both direct and indirect water use of a consumer or a producer. The concept of water footprint can be applied to business companies to provide indications about the sustainability of their production process. The water footprint of 1 kg of Barilla pasta has been shown to range between 1.336 and 2.847 l of water, depending on the production site, local environmental conditions and agricultural techniques used to cultivate durum wheat (Ruini et al. 2013). Agricultural production was the largest water consumer, accounting for 96%of the WF .The remaining 4% was for the industrial and domestic sectors. The blue of WF was 811 million m3 yr−1. This indicates a blue water proportion of 46 %, which is much higher than the world average and China's average, which is mainly due to the aridness of the HRB and a high dependence on irrigation for crop production. Even in such condition, blue WF was still smaller than green WF, indicating the importance of green water. They find that blue WF exceeded blue water availability during eight months per year and also on an annual basis. This indicates that WF of human activities was achieved at a cost of violating environmental flows of natural freshwater ecosystems, and such a WF pattern is not sustainable (Zeng et al.,2012.)

The water footprint can be regarded as a comprehensive indicator of freshwater resources appropriation, next to the traditional and restricted measure of water withdrawal. (Liqiang et al.,2011). The water footprint can be regarded as a comprehensive indicator of freshwater resources appropriation, next to the traditional and restricted measure of water withdrawal, based on the concept and calculating method of water footprint. Land area water footprints are often used in the accounting of national or regional trade in water. This trade in virtual water is the exchange of products that are represented by the consumptive water volumes required to produce them (Hoekstra., 2010). The water footprint is defined as the total volume of water used during production and consumption of goods and services as well as direct water consumption by humans (Hubacek et al.,2010.) . Water is not only consumed directly but also indirectly in production processes. So, for calculating the water footprint enables us to quantify total water consumed along the whole global supply chain. In this paper, they have developed a regional input output model extended by water consumption coefficients to quantify the respective domestic water footprint for different consumption categories.

Crop evapotranspiration is an important component of simulation models with many practical applications related to the efficient management of crop water supply. The algorithms used by models to calculate ET are of various complexity and robustness, and often have to be modified for particular environments. We chose three crop models with different ET calculation strategies, CROPWAT with simple data inputs and no calibrations for intensive inputs and limited calibrations, and CERES-Wheat with intensive inputs and more calibrations for parameters (Allen et al.,2009). The three models tended to overestimate daily ET when measured ET was small, and to underestimate daily ET when measured ET was large. The fitted values of daily crop coefficients, calculated from daily ET and reference ET, Leaf area index was poorly calculated by MOD Wheat and CERES-Wheat, especially when using the Priestley Taylor method to estimate potential ET. Poor overall ET calculation of three models was associated with poorly estimated values of PET or ET0, Kc and LAI as well as their interactions.

The water footprint studies in most cases analogous to the methodology taken in EF studies, but deviates at some points. As a result one can exactly localize the spatial distribution of a water footprint of a country. With respect to the outcome of the footprint estimates, one can see both similarities and striking differences. Food consumption for instance contributes significantly to both the EF and the water footprint, but mobility is very important only for the EF (Hoekstra.,2009). They have compare the methodologies in EF and water footprint studies, compares nation's footprint estimates and suggests how the two concepts can be interpreted in relation to one another. In another paper (Hoekstra et al.,2006) discussed about calculating the water footprint for each nation of the world for the period 1997–2001. The USA appears to have an average water footprint of 2480m3/cap/yr, while China has an average footprint of 700m3/cap/yr. The global average water footprint is 1240m3/cap/yr. The four major direct factors determining the water footprint of a country are: volume of consumption pattern climate and agricultural practice.

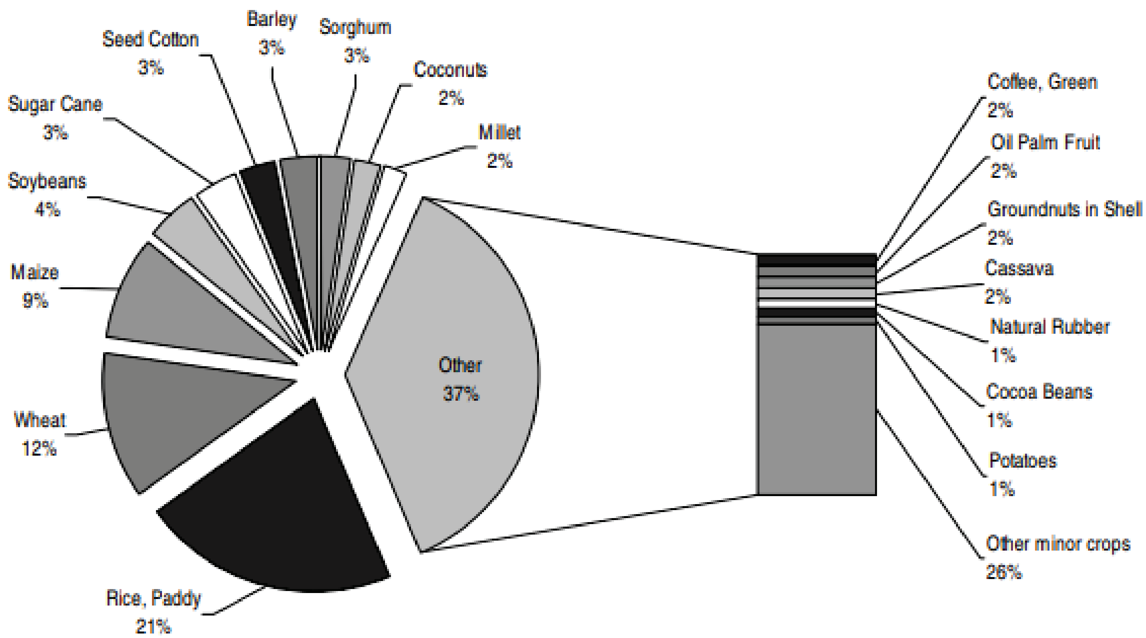


Fig. Contribution of different crops to the global water footprint

In one research article they have focused on the green and blue water footprint of rice, wheat, soya bean and maize crops. They have done sensitivity analysis for precipitation, reference evapotranspiration, crop coefficient, Smax and crop planting date and uncertainty analysis for precipitation, reference evapotranspiration, combined precipitation and crop coefficient and combined uncertainties in precipitation, crop coefficient, reference evapotranspiration and crop planting date. They have used one-at-a time method for calculation sensitivity analysis and the results states that the sensitivity and uncertainty are differs from crop types. The smaller the annual blue water footprint is, the higher its sensitivity to changes in PR, ET0, and Kc (Zhuo et al.,2006).

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crop types. The smaller the annual blue water footprint is, the higher its sensitivity to changes in PR, ET0, and Kc (Zhuo et al.,2006).

Developing a sustainability index involves various steps, some of which have uncertainties associated with them. For the recently developed West Java Water Sustainability Index (WJWSI), three sources of uncertainties were identified, namely uncertainties in the thresholds of non categorical indicators and sub-indicators, in the weighting schemes, and in the aggregation methods (juwana et al., 2006). The sensitivity analysis, measured by the correlation coefficients between the final index and the thresholds, indicate that changes in the thresholds of WJWSI indicators have not significantly affected the sub-index values of most indicators and sub-indicators. The sensitivity analysis also concluded that either the equal weighting scheme can be used for future use of the aggregation of West Java Water Sustainability Index indicators and sub-indicators, as changes from equal to non-equal weighting scheme did not significantly affect the final index. This paper presents the uncertainty and sensitivity analysis of West Java Water Sustainability Index, based on the application of West Java Water Sustainability Index to Citarum catchment. The uncertainty analysis, measured by the coefficient of variation of the thresholds and the sub-indices, indicates that the minimum thresholds of Land Use Changes, Coverage, Education, Poverty, Health Impact and Sanitation, and the maximum threshold of Water Quality have higher variation when compared to variation of the other thresholds.

Conclusions

Sensitivity Analysis results are presented without sufficient discussion of their consequences and implications for the central issue. To avoid these traps, the following points have been recommended as a standard minimum.

From the base model, or other information, initial optimal recommendation which is to form the standard for comparisons in the sensitivity analysis may be provided. The parameters most affecting the optimal recommendation are essential. A table of values for a sensitivity index ranked according to their absolute value is to be recommended. If appropriate, what are the break-even levels of parameters for changes in the recommendation, how does the optimal recommendation change if the important parameter changes, what are the consequences of not following the optimal recommendation and with what level of confidence we are recommending the optimal range etc are to be discussed and detailed.

It is particularly important as it ensures that the discussion of the sensitivity analysis will be well focused and relevant. The recommendation to state the level of confidence is not easy to a formal probabilistic or statistical statement, but at least some relatively informal and subjective statement of confidence should be made. As noted above, a helpful strategy in this regard is to demonstrate that certain parameters have little impact on the important decision variables, and then to avoid reporting further results for these parameters.

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SWACHHTA ACTIVITY:

Parthenium hysterophorus, known as "Congress grass" in India, has spread to more than 40 tropical and subtropical countries, earning its place in the list of the world's 100 worst invasive species. The alien has invaded almost all Indian states as well, as per estimates; its invasion has resulted in yield losses of up to 40% in several crops in the country and has also caused a 90% drop in forage production. It causes health problems too. While indirect or direct contact with parthenium can cause skin problems and allergies in people, the plant is toxic to livestock. The spread of weed is more in open places; therefore, weed was uprooted in Residential campus of NIPHM to make it parthenium free.

Before and after pictures of Parthenium removal activity in Residential campus of NIPHM

DETAILS OF PLANT BIO-SECURITY DIVISION ACTIVITIES (April-June, 2020)

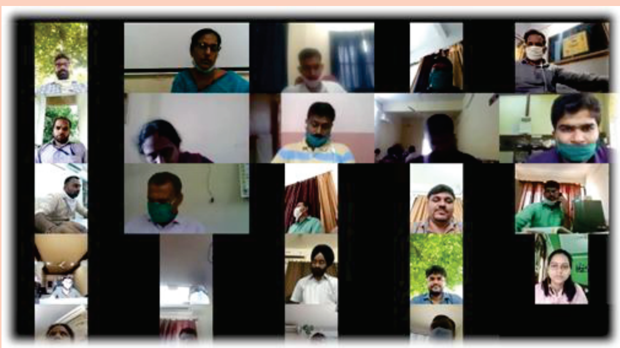
The Plant Biosecurity Division has organized following training programmes during the month of **April - June, 2020.**

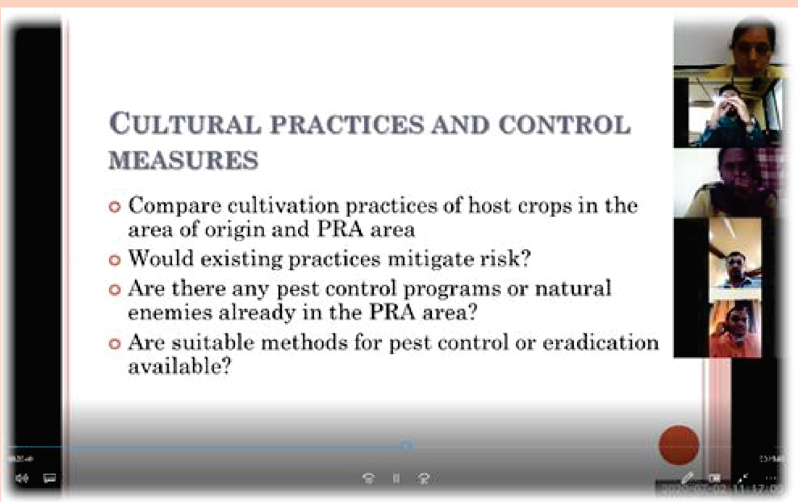
CAPACITY BUILDING PROGRAMMES:

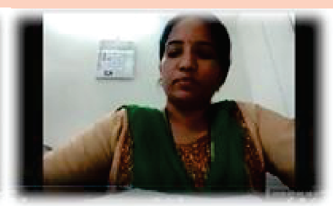
Sl. No	Name of The Programme	Duration (Days)	Date	
			From	To
	On campus training programmes (Officers)			
2	Organic farming for sustainable agriculture	5	29.06.2020	03.07.2020

1. DETAILS OF TRAINING PROGRAMMES (On Campus)

a. Pest Risk Analysis: A Five days training programme on "Pest Risk Analysis" was organized through online platform at NIPHM from 29th June to 3rd July, 2020. In order to prevent the entry and spread of destructive pests, it is important to identify potential risks at an early stage and propose technically justified phytosanitary measures to mitigate these risks. The objective of PRA is to decide whether pests should be regulated or not as quarantine pest and propose risk management options. PRA plays a vital role in trade of agriculture goods.






2. PLANT HEALTH CLINIC PROJECT ACTIVITIES:

PHC activities were carried out through phone calls and giving the timely advisory solutions to the farmers. The farmers have also shared the images showing the symptoms of damage for some of the crops infested with pests (insects/diseases) for control measures of particular pests. Whenever needed visits were made in the fields of farmers to give them required and significant suggestions & recommendations.

Plant Health Clinic activities at Suryapet:



Field scout visit to citrus and mango orchards



Visit of filed scout to different fields in suryapet district

Plant Health Clinic Activities at Warangal

The field scouts along with the respective mandal horticulture officer has visited the villages of Warangal Urban (Vangaphad, Mulkanoor, Devannapet, Pantini villages) & Warangal Rural (Togarrai, Wardhannapet, Chinthanekkonda, Nandhigama, Geesugonda). The major crops under cultivation in these areas are mango, Papaya, banana, guava, brinjal, cabbage, tomato, okra, watermelon, cucumber, bottle gourd and green chilli.


Okra field visit & Powdery mildew disease inj okra field


Detection of pests and diseases in Mango field & Interacting with the farmers


Visit to Papaya & Cucurbits fields for detection and Diagnosis of Pests



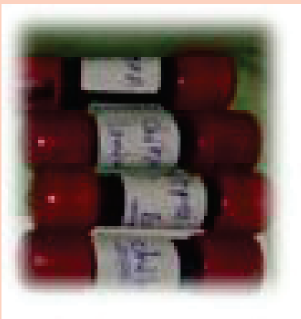
Detection and Diagnosis of Pests in Papaya & Fruit & shoot borer in Brinjal

3. BULK PULSES IRRADIATION PROJECT

Mung bean, Chickpea and Pigeonpea in bulk 20 kg each in three replication treated with minimum dose of 683 Gy with Gamma irradiation at Mumbai Irradiation Facility in HDPP bags without lamination, HDPP bags with lamination and Urea bags. Each Pulse was inoculated with of all stages of pulse beetle infestation before treatment. After treatment these were stored at NIPHM and monthly interval observed for the pulse beetle development. No pulse beetle further development seen in all pulses stored at different storage bags.



Pulses selected for Irradiation treatment



Irradiation of Pulses



Pulses after Six Month of Irradiation



Pulses Untreated

DETAILS OF PLANT HEALTH MANAGEMENT DIVISION ACTIVITIES (April to June)

1. AICRP ON BIOLOGICAL CONTROL OF CROP PESTS (ICAR-AICRP-BC) NIPHM, HYDERABA

Participated in XXIX Annual Group meet of All India Co-ordinated Research Project on Biological control of Crop Pests 21- 22 May 2020 through Video conference.

A. NAME OF THE PROJECT: STUDIES ON BIODIVERSITY OF NATURAL ENEMIES IN MAIZE ECOSYSTEM:

Summary of trial carried out during Kharif, 2019:

The Experiment was conducted on Studies on biodiversity of natural enemies in the Maize ecosystem at NIPHM Farm and Survey was carried out in farmers maize fields during *Kharif*, 2019. The different natural enemies were recorded during the study. A total of fifteen natural enemies including parasitoids and predators belonging to the orders Coleopteran like predatory ladybird beetles viz., *Coccinella septempuctata* Linnaeus., *Cheilomenes sexmaculata* Fabricius., *Coccinella transversalis* Fab., *Micraspis discolour* Fab., *Menochilus sexmaculatus* Fab., *Harmonia dimidiata* Fab., *Scymnus nobilis*, *Neuroptera*, Green lacewing (*Chrysoperla sp),* Hemiptera, Big eyed bugs (*Geocoris sp*), Hemipteran reduvid bug, *Rhynocoris fusipes*, and Hymenopteran were recorded from maize ecosystem during *Kharif*, 2019 at NIPHM farm. Whereas during the survey in farmers fields, a total of eight natural enemies including parasitoids and predators belonging to the orders Coleoptera, Neuroptera, Hemiptera and Hymenoptera *Cotesia sp, Bracon sp* and *Trichogramma sp*.

Heteroptera and Hymenoptera were recorded from the maize ecosystem during *Kharif*, 2019. *Cheilomenes sexmaculata* Fabricius., *Coccinella transversalis* Fab., *Micraspis discolour* Fab., *Menochilus sexmaculatus* Fab., *Harmonia dimidiata* Fab., *Scymnus nobilis* Mulsant, *Podisus maculiventris* say., *Chrysoperla sp, Rhynocoris fusipes* Fab., *Geocoris sp*. The parasitoids reported are *Cotesia sp., Bracon sp* and *Trichogramma sp* **(detailed report enclosed)**.

B. EVALUATION OF NIPHM WHITE MEDIA FOR THE PRODUCTION OF *Nomuraea rileyi (Metarhizium rileyi)* NIPHM MRF-1 STRAIN FOR MANAGEMENT OF MAIZE FALL ARMYWORM *(Spodoptera frugiperda)*

- Evaluation of NIPHM white media and broken rice grains for mass production of Nomuraea rileyi (Metarhizium rileyi)
- To check the quality of Nomuraea rileyi (Metarhizium rileyi) produced on broken rice grain and NIPHM white media periodically
- Observation of Nomuraea rileyi inoculated in NIPHM white media and SMYB media
- Results of the quality analysis of Nomuraea rileyi produced in 2% NIPHM white media were recorded and interpreated.
- Observation of Nomuraea rileyi inoculated in NIPHM white media and SMYB media

2. CROPSAP STEERING COMMITTEE MEETING 2020-2021

Dr. E. Sreelatha, AD-PHM & Dr. K. Damodara Chari, ASO (Micro) have participated in 1st steering committee meeting for CROPSAP project through Video conference (Microsoft teams).

The video conference meeting was chaired by Commissioner of Agriculture, Maharashtra. The meeting was participated by senior officers of the Department of Agriculture and Horticulture, representatives of state Agricultural Universities., NCIPM, and other stakeholders involved in the Crop Pest Surveillance Advisory

Project (CROPSAP). During the meeting;

- Submitted the Utilization certificate and training report.
- Discussion held with some stakeholders needs to advanced and strategic measures to control Pink bollworm and Fall Army Worm during Kharif 2020-2021.
- The commissioner conveyed that, in the view of emerging pest problems ie. Desert locust control measures and Egg laying control measures need to be taken through literature etc.
- During the meeting, white grub infestation problems in sugarcane raised by some stakeholders.
- It was informed about the efforts and experiments being conducted by NIPHM for the management of white grub with EPN cultures. If permits the cultures and material of control measures will be provided for the upcoming season due to physical pieces of training is hold up with COIVD-19 pandemic.
- The commissioner appreciated the achievements of the project and wanted to strengthen the project with IT interventions

3. VILLAGE ADOPTION PROGRAMME

NIPHM OUTREACH PROGRAMME ON PROMOTION OF ORGANIC FARMING AT MOHAMMED NAGAR (VILLAGE) MEDAK DISTRICT

As per the instructions by Director PHM, under the village adoption program, communicated through a telephone conversation to collect crop status information with selected chilli farmers and with Ekalavya Foundation, the KVK staff. NIPHM staff communicated with selected chilli farmers KVK staff to know Chilli crop status. IIHR and Non-IIHR varieties are showing healthy growth. Whereas IIHR variety (Arka Khyati) shown good crop growth and development compared to Non-IIHR variety. The recommendation was suggested for the fruit rot and collar rot by Mr.Ravi Scientist KVK, when visited all five chilli fields.Farmers did not harvest green chilli due to low market price and they decided to harvest red chilli. Suggested to record separate yield data for both varieties and SRF will be coordinating for this data from selected farmers.


observed crop chilli status in a farmers field

Observed fruit rot

KVK officers visited farmers' fields and recommended for fruit rot

farmers updated Crop status

Farmers cultivating for dry chilli

4. INSTITUTIONAL IPM INSTRUCTION FARM

The soil is ploughed and ready for sowings. Field operations like cleaning and preparation of the field have been completed.

Polyhouse:

- Installed Hydrophonic unit (Vertical Line Model and Horizontal Line Model) in Polyhouse
- Applied red soil and FYM in Polyhouse for further cultivation
- As per the instruction of the Director (PHM) Polyhouse plan of Kharif 2020-21 was prepared and submitted.

5.TOBACCO BOARD INDENT AND SUPPLY

The biopesticides' cultures revived and the Biopesticide, *Pseudomonas fluorescens* (2550L) & *Trichoderma harzianum*(2550 L) produced, the quality test was done and supplied to the tobacco board in time.

PESTICIDE MANAGEMENT DIVISION ACTIVITIES (April-June)

A. SAMPLE ANALYSIS

Pesticide Formulation and Residue Analytical Centre (PFRAC) of Pesticide Management Division (PMD) is an accredited laboratory by National Accreditation Board for Testing and Calibration Laboratories (NABL) as per ISO/IEC 17025:2005 in the field of chemical analysis. The laboratory is well equipped with latest analytical equipment like GC-MS/MS, LC-MS/MS, GC-TOF & LC TOF, GLC and HPLCs besides

IR & UV-vis Spectrophotometers.

- The PFRAC of PMD is one of the 32 laboratories under GOI funded Central Sector Scheme *"Monitoring of Pesticide Residues at National Level (MPRNL)"*. The PMD collects various market and farm gate samples of different agricultural commodities and analyze for pesticide residues, on monthly basis. During the period of April – June, 2020, PMD has collected 274 samples from various markets of Hyderabad. The collected samples were tested for presence of pesticide residues and the results were forwarded to Member Secretary of MPRNL.
- ***Central Insecticides Laboratory (CIL):*** Ministry of Agriculture, Government of India, vide Gazette Notification No: 132, March 12, 2013, in exercise of powers conferred by proviso to Section 16 of the Insecticide Act, 1968, read with Rule 5 of the Insecticides Rules, 1971, declared NIPHM, to perform the functions of Central Insecticides Laboratory (CIL) in respect of bio-pesticides, to analyse the samples of bio-pesticides for chemical substances under the provisions of Insecticide Act. The Bio-product Analysis Laboratory of the division has the capacity of screening bio- product for presence of 218 types of chemical pesticides. During the period of April – June, 2020, PMD has received 24 samples from Insecticide Inspectors of various States and the samples were analyzed for presence of chemical substances under the provisions of Insecticide Act, 1968.
- PFRAC of PMD also analyses samples received from certain customer. During the period of April – June, 2020, PMD has received 60 samples of Tobacco from Tobacco Board, India and the samples were analyzed for presence of pesticide Residues.

B. PROFICIENCY TESTING

Proficiency Testing Centre (PTC) was established during 2015-16 at NIPHM for conducting Proficiency Testing Programs in the field of Pesticide Formulation and Residue Analysis. The purpose of PT is to check the accuracy of the result submitted by the participating Laboratory and it is achieved by comparing participant's results to the assigned value. The participants performance assessment is determine by 'Z' score. The PT activity of NIPHM has been assessed and accredited in accordance with the standard ISO/IEC 17043:2010 *(conformity Assessment–General requirements for Proficiency Testing)* as Proficiency Testing Provider in the field of Chemical Testing by NABL.

During the April to June, 2020, PT program for 3 pesticides were conducted in Pesticides Quality Control.

Sl. No	Pesticide	Test Parameters	No. of Participants
1	Imidacloprid	Active Ingredient	65
2	Cartap hydrochloride	Active Ingredient	60
3	Copper Oxychloride	Active Ingredient & Suspensibility	60

Plant Health Engineering Division:

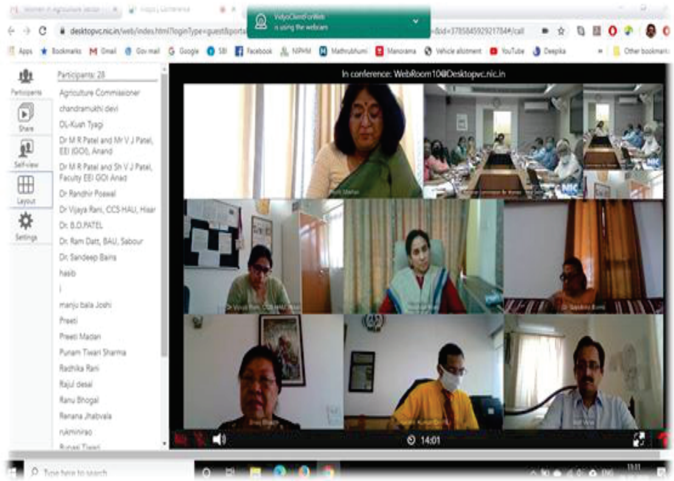
The division assigned the preparation of 4 journal papers on the on-going research works for publication under the following topics.

- A Review on Use of Hyperspectral Image in Agriculture.
- A Study on Performance of NIPHM Light Trap.

- Development and evaluation studies on cost effective maize sheller
- Effect of awareness on practicing guidelines on safety and productivity of spraymen-A village pilot study
- A review on effect of spray patterns on various depending parameters for optimum selection of nozzles.
- Design, development and evaluation of a cost effective handheld sprayer for field crops.

Faculty attendance in trainings / workshops

- Joint Director, PHE, Dr. Vidhu Kampurath participated as a resource person in the Webinar organized by NCW on 'Women in Agriculture Sector: Consultation on Facilitating a Better Role' on the 8th May, 2020 (Friday) from 10.30 A.M to 02.00 P.M. The webinar was organized by National Commission for Women, a Statutory Body mandated to safeguard the constitutional rights of women. The webinar was aimed at suggesting measures for gender equality in agricultural sector and to ensure that Women's contribution in this Sector and in the allied fields is recognized with adequate steps to protect their rights.



- Joint Director (PHE), Dr. Vidhu Kampurath and SO (PHE), Er. Udaya Bahnu attended and successfully completed 5-day online training course on 'Fundamentals of Robotics for Precision Agriculture' from 26th to 30th May, 2020, organized by Center for Advanced Agriculture Science and Technology for Climate Smart Agriculture and Water Management, (CAAS-CSAWM), Mahatma Phule Krishi Vidyapith, Rahuri.
- Joint Director (PHE), Dr. Vidhu Kampurath participated and presented a paper on 'Use of programmed drones for effective spraying applications' under the theme New thrust areas in agriculture, in the National webinar organized by Maharana Pratap University of Agriculture and Technology, Udaipur on 29th May 2020.
- Dr. Vidhu Kampurath, JD (PHE) attended in one week online International training on “Present and Futuristic Trends in Agricultural Mechanization” during 18th to 23rd June 2020, conducted by Center of Excellence for Digital Farming Solutions for Engahncing productivity, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.
- Dr. Vidhu Kampurath, JD (PHE) participated in online training session on “Power of digital manufacturing (3D printing) for new product development”on 25th June 2020, conducted by Center of Excellence for Digital Farming Solutions for Engahncing productivity, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.
- Er. Udayabhanu, SO (PHE) delivered an expert lecture on “Role of Pesticide Application Techniques in Plant Health Management” on 29th June 2020 in BIOFACET – PLANT HEALTH MANAGEMENT organized by college Chikitsak Samuha's Sir Sitaram and Lady Shantabai Patkar College of Arts and

Science and V.P. Varde College of Commerece and Economics, Mumbai.

- Dr. Vidhu Kampurath, JD (PHE) and Er. Govind Kumar Maurya, ASO (PHE) participated in the Webinar organized by Agro vision foundation & Agro Spectrum on 'Scope of farm Mechanization in India' on the 30th June, 2020. The webinar was aimed –
- Available machinery to helps soil Management
- Development of Machinery agro-eco system
- Designing of Machinery & Equipment helps to maintain safety, environment and farm machinery management

Report on the online training programme (June 2020)

Due to the current COVID 19 situation, the division was not able to convene a physical training and hence requested to conduct an online session where, theoretical concepts of spraying techniques, nozzles and its classifications, calibration procedure, safety aspects etc. can be detailed. Accordingly, division floated a 5-day online training programme from 1st to 5th June 2020. A total of 735 applications were received till closing of registration on 29th May 2020, for the programme. As the applicant number was more, division proposed to conduct the training for the officers and accordingly, 131 officers were shortlisted for the programme. Out of the total registered candidates, 82 participants were found eligible for certificates.

Hindi Activities

NIPHM प्रशिक्षण कार्यक्रमों में भाग लेने के लिए देश विदेश से कृषि अधिकारी, वैज्ञानिक, विद्यार्थी एवं कृषकजन वर्षभर आते रहते है। यहाँ आने के बाद संस्थान परिसर एवं शिक्षण प्रशिक्षण उनको इस तरह से प्रभावित करता है कि कार्यक्रम सम्पन्न होने के उपरान्त उनके लिए संस्थान परिसर छोड़ना और अपने साथियो से बिछुड़ना मुश्किल हो जाता है। इसी तरह के भाव एक प्रशिक्षणार्थी ने अपने शब्दों मे कार्यक्रम के समापन सत्र में इस प्रकार व्यक्त किये है,

बिछड़ा है जो एक बार

बिछड़ा है जो एक बार तो मिलते नहीं देखा,
इस जख्म को भरते नहीं देखा।
इक बार चाट गई जिसे धूप की चाहत,
फिर शाख पे उस फूल को खिलते नहीं देखा।
धड़ाम से जो गिरा है तो जड़े तक निकाल आई,
जिस पेड़ को आँधी में भी हिलते नहीं देखा ।
काँटों में घिरे फूल को चूम आएगी लेकिन,
तितली के पेरों को कभी छिलते नहीं देखा ।
किस तरह मेरी रूह को हरी कर गया आखिर,
वो जहर जिसे जिस्म में उतरते नहीं देखा ।
पढे बहुत, स्कूल कालेज भी गए लेकिन,
ज्ञान विज्ञान एवं अनुशासन NIPHM जैसा नहीं देखा।
बिछड़ा है जो एक बार तो मिलते नहीं देखा,
इस जख्म को भरते नहीं देखा।

\- श्री संदीप कुमार, रतिया (हरियाणा)
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