

UDef-ARP was developed by Clark Labs, in collaboration with TerraCarbon, to facilitate implementation of Verra's VT0007 Unplanned Deforestation Allocation Tool (UDef-AT). It is used in conjunction with a raster-capable GIS for input data preparation and output display. Tools are provided for the development of models using the Calibration Period and subsequent testing during the Confirmation Period. Based on these evaluations, the selected procedure uses the full Historical Reference Period to build a model and prediction for the Validity Period. The final output is a map expressed in hectares/pixel/year of expected forest loss.

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## HARDWARE REQUIREMENTS

UDef-ARP was created with open source tools. In the current version, all raster inputs are stored in RAM during processing. Therefore, large jurisdictions will require substantial RAM allocations (e.g., 64Gb). The interface was developed in Qt 5. A minimum screen resolution of 1920 x 1080 (HD) is required. A 4K resolution is recommended.

## CREDITS

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### UDEP-ARP VERSION 1.0

#### Software Research and Development:

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### UDEP-AT DEVELOPMENT TEAM

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## GENERAL INSTRUCTIONS

UDef-ARP is designed to facilitate implementation of Verra's UDef-AT. UDef-AT has two stages and two phases within each. The stages are 1) testing and 2) application. The testing stage is intended to evaluate and select the modeling procedure that will be used. The application stage is where the selected modeling procedure is used to develop an allocated risk map for the Validity Period. Below is a general description of these stages. In use, we recommend that users access dialog-specific help by clicking the help button.

### THE TESTING STAGE

For testing, every model goes through a fitting phase where the model is developed using the data from the Calibration Period and a prediction phase where the model is used to create a prediction for the Confirmation Period. For both the fitting and prediction phases, there are three steps with the buttons on the left being labeled with numbers.

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#### STEP 1: VULNERABILITY MAPPING

The first step is the vulnerability map development step. At present, UDef-ARP only implements the Benchmark vulnerability map procedure. Users will need to develop their own 30-class vulnerability map for alternative models. Clark Labs plans to offer a utility to facilitate the creation of vulnerability maps for alternative models in the near future.

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#### STEP 2: ALLOCATED RISK MAPPING

The second step creates the allocated risk map. In the case of the fitting phase, the allocated risk is in the form of a density map along with a modeling region map and a relative frequency table for the Calibration Period. For the prediction phase, the allocated risk is a predicted density for the Confirmation Period.

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#### STEP 3: MODEL EVALUATION

The Model Evaluation step during the fitting phase is used to determine the goodness of fit of the allocated risk to the deforestation during the Calibration Period. We recommend saving the performance chart. The Median Absolute Error (MedAE) is the measure of goodness of fit. During the prediction phase, the Model Evaluation determines the skill of the prediction for the Confirmation Period. The MedAE statistic serves this purpose in this context.

Both the Benchmark method and every modeling alternative must be evaluated using these two measures. If the alternative has a lower (i.e., better) MedAE for both the fit and the prediction, then it qualifies for use in the Application Stage. Otherwise, the Benchmark must be used.

### THE APPLICATION STAGE

After a modeling technique has been selected using the procedures of the Testing Stage, the final allocation of risk can commence. Again, there are fitting and prediction phases. For the fitting phase, the entire Historical Reference Period (HRP) is used. This phase fits the model to the historical data. The prediction phase then applies this model to produce a prediction for the Validity Period. Unlike all of the previous steps, the output of the prediction for the Validity Period is expressed in densities per year (ha/pixel/year).

For the Application Stage there is no Evaluation step since the modeling technique has already been determined. Thus, there are only two steps:

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#### STEP 1: VULNERABILITY MAPPING

As in the Testing Stage, the first step is the vulnerability map development step. The logic is the same – just the period of time is different. At present, UDef-ARP only implements the Benchmark vulnerability map procedure. Users will need to develop their own

30-class vulnerability map for alternative models. Clark Labs plans to offer a utility to facilitate the creation of vulnerability maps for alternative models in the near future.

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## STEP 2: ALLOCATED RISK MAPPING

This step parallels that used in the Testing Stage. However, in the prediction phase for the Validity Period, it will ask for the expected deforestation activity. This value will be used to adjust the allocated risk to an annual rate expressed in ha/pixel/year.

## IMPORTANT NOTES

1. **Important:** Map error can be a major problem. False mappings of non-forest are particularly problematic. If areas of dense forest are seen to have very small inclusions of non-forest, be very suspicious of their veracity and check carefully. Such false inclusions of non-forest can create massive problems for the vulnerability maps used in this process. Consider the possibility of using a sieve filter to remove small isolated patches of non-forest as well as small isolated areas of deforestation. In TerrSet this is called AREAFILTER. In ERDAS it is called SIEVE. ArcGIS does not have a sieve filter, but it can be achieved with the RegionGroup, ExtractByAttribute, SetNull and Nibble tools. GDAL\_Sieve.py is another possible solution. This filtering does not affect the ultimate allocation. In the case of the vulnerability maps, it's just focusing the vulnerability where it is more likely. In the case of filtering the deforestation maps, the ultimate allocation is matched to the sampled activity data, so removing these likely errors does not affect the final allocation.
2. At this time, raster inputs and outputs can be in TIF (GeoTiff) and RST (TerrSet) formats. Be sure to specify the extension (".tif" or ".rst") when supplying the names of inputs and outputs.
3. Several inputs are needed in the form of binary maps that contains 1's and 0's. A map with 1's and NAN's is not equivalent and should not be used. For example, with a map of forest cover, 1's mean forest and 0's mean non-forest. The 0's are data.

## CONTEXT SENSITIVE HELP

Each dialog of the UDef-ARP has a help button. Clicking Help will launch a help document specific to that dialog.