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The document is a set of suggestions on starting to use APEX and moving forward with the latest setup for the Vinkenloop catchment.

1. **Getting started with APEX**

APEX runs via the Windows Command Prompt. To do so, the following commands are provided in the Command Prompt window:

cd “C:/Users/…<folder\_path\_where\_apex1501\_is\_stored>”

apex1501.exe

Buttons in the APEXEditor Excel workbook are the alternative way to run APEX. It should be noted that errors messages encountered when running the model are only seen when the model is run via Command Prompt and not when it is run using the APEXEditor buttons.

The latest model files for the Vinkenloop catchment can be found here: [nshahi60/Modelling-water-quality-using-APEX-for-Vinkenloop-catchment-Netherlands](https://github.com/nshahi60/Modelling-water-quality-using-APEX-for-Vinkenloop-catchment-Netherlands)

The folder TxtInOut contains all input and output files, the model software and the APEXEditor Excel workbook. The latest version is the workbook named “APEXeditorRev2203\_v4\_17\_07\_25”.

1. **Input file configuration**

*Recommended order for understanding/changing input files if you’re doing it from scratch: Files not dependent on other input files (Weather, Soil, Wind) 🡪 files with some dependencies (Operations, subarea) 🡪 Main control files (APEXCONT, APEXRUN, PRNT, etc.).*

The different input files were modified by adding the Vinkenloop parameters one by one, starting with the weather, wind and soil files, in this sequence. Their respective .LIST files were modified simultaneously. These files have input for the subarea file so the subarea file was generated after these, followed by the operations file. Finally, the control files were modified as stated below.

The APEXFILE.DAT, APEXRUN.DAT, APEXCONT.DAT, APEXDIM.DAT were modified to include catchment-specific parameters and simulation parameters such as the simulation time period and methodology used for runoff estimation, soil erosion, evapotranspiration, etc.

Several standard APEX input files were either left unchanged or excluded, depending on model requirements for this study. TILL\*\*\*\*.DAT, CROPCOM.DAT, FERTCOM.DAT, PESTCOM.DAT and PARM\*\*\*.DAT were not modified as they contain the fixed parameters for tillage, crops, fertilizers, pesticides and model parameters respectively. The default parameters given in these files were used.

MLRN\*\*\*.DAT, HERD\*\*\*.DAT, PSOCOM.DAT, FILENAME.PSO, RFDT\*\*\*.DAT and FILENAME.HLY are respectively for multiple-runs, herd grazing, point sources, within-storm rainfall. They were not used as these parameters are not relevant for the Vinkenloop.

APEX uses several list files to reference inputs. The SITE.LIST, MNGT.LIST, SOLC.LIST, WDLY.LIST, WPM1.LIST, WIND.LIST and SUBA.LIST are respectively for including filenames of the site, operations, soil types, weather stations, monthly weather, wind and subarea files. Since this was a small catchment, single input of soil type, weather station and sites were used. Two kinds of operations were used, for grasslands and arable crops.

1. **Most frequently-used resources**

Google group: [EPIC / APEX Modeling Forum - Google Groups](https://groups.google.com/g/agriliferesearchmodeling)

APEXEditor introduction: [APEXeditor: A Spreadsheet-Based Tool for Editing APEX Model Input and Output Files](https://www.scirp.org/journal/paperinformation?paperid=96106)

Manual: [APEX1501 User Guide](https://epicapex.tamu.edu/media/pkff4m34/the-apex1501-user-manual-november-2023.pdf)

Theoretical manual: [APEX0806 Theoretical Documentation](https://epicapex.tamu.edu/media/2mwdlhte/the-apex1501-theoretical-documentation-january-2023.pdf)

Conservation Practice modelling guide for SWAT and APEX: [NCTWQP LOGO](https://07147075471679974488.googlegroups.com/attach/70150955f2032/Conservation%20Practice%20Modeling%20Guide.pdf?part=0.1&view=1&vt=ANaJVrEcmoJYd2kC-3w-d3mulKwiYGjMXB1cB_5mC-XsjnQquLHpFm2yFNTY4PF7HJvDGtdZ1fVKXCK_zp6KYWzcSNLLbt06dIRM-G9uHvAbCO1pXck0W04)

Simulating buffer strip in APEX: [Microsoft Word - buffer strip.docx](https://07147075471679974488.googlegroups.com/attach/35887cb8b6ddf109/buffer%20strip.pdf?part=0.1&view=1&vt=ANaJVrHkGC2IRTMcSRQX3O5ULI1bjLRpVrNDY8fjoLW5EjcmV7Lb1WVM2bgNXBI_szPqsqF9ory0NLfSSL_Z6CY14evmTXSeROEZRMFUvcmPXVs41C6XGfM)

You could start by going through the manual and each file and input stated there to get an overview and check if you're able to run the model on your system.

The Python scripts available on the github link can be used for processing the outputs.

1. **Calibration tool**

APEX-CUTE is the automatic calibration tool available on the website. It also provides options to run a sensitivity analysis. I used the APEX-CUTE 7.10 version. The observation data may not be complete as I only did the initial run. You can verify it and modify it based on the watershed or the specific subarea you are looking at.

Note: Convert the date and time format of your system to US format otherwise, APEX-CUTE crashes.

1. **PRNT file inputs for printing water, N, P and C outputs**

The PRNT file takes inputs to decide which output variables are printed and there is a restriction on the number of output variables in certain files. Table 2.9 from the User Guide is very helpful to look at all possible input variables at once and choose which you prefer. The Excel sheet available on the GitHub link named “SAD Parameters” in the spreadsheet called “SAD parameters in PRINT\_DAT” contains the parameter values for printing all daily output related to one of the fluxes among water, N, P and C. The modification is in ‘line 8-9’. Note that you would need to modify these codes when you’re using the Python script for a different nutrient, otherwise the output will not be found in the SAD file.

1. **Python scripts**

The most used Python scripts for me were ‘Validation\_outflow.ipynb’ and ‘Cumulative daily water balance visualization.ipynb’. The ‘DLY\_WP1\_WND.ipynb’ and ‘Weather\_APEX.ipynb’ can be used to get the weather inputs in the correct format from KNMI weather files for other periods, if needed.

Other codes run successfully but were not used that often since I worked more on the hydrological outputs. They could be useful at a later stage.

**OTHER NOTES**

**1. APEXEditor bug**

When using APEXEditor, the command buttons, “Get files”, “Run”, “Write” and “Read” became larger in some sheets with each use, eventually occupying the entire Excel screen. To fix this issue, the following steps were followed:

Press ‘Alt + F11’ à Opens VBA code à Enable ‘Designer mode’ à Right-click on button to be resized à Select ‘Properties’ à Set ‘Autosize’ = ‘False’ and ‘Move and Size with cells’ = ‘False’.

**2. Weather file format**

The weather file is supposed to have nine valid fields of six columns, even if they are blanks. If the format is incorrect, APEX does not give any warning and defaults to using weather generated from monthly statistics. This can lead to erroneous results in the output, especially if monthly statistics which may not include critical values.

Refer to this thread regarding the weather input and how to verify it: [Daily weather ignored?](https://groups.google.com/g/agriliferesearchmodeling/c/xyc3r9m9Q_U)

APEXEditor does not add the last three variables if the weather file is made using it so the current weather file was modified using Notepad++ and I don't use APEXEditor to update the weather file anymore, else the changes will be lost.

**3. Repetition and inconsistencies in output files**

There are multiple output files, some of which have overlapping output variables. For instance, both .DLL file and .KKK files have precipitation for the subarea. In many cases, a choice had to be made between the different output files to select a file which had all the relevant water variables for the area.

The .OUT file contains run-wide details but is extremely long and the manual does not have an explanation of how to read this file. This makes it difficult to use data from this file even if it may have relevant output. The APEX/EPIC Modelling Forum Google Group has explanations of variables in the .OUT file and some are present in the final sections of the APEX manual, while most of the explanation is lacking.

The variable names in the manual and the actual output files are not consistent at times. For instance, the ENMA variable from the .OUT file is mentioned in the manual, but no description of this variable is provided. The explanation about some of these variables may be found on the Google group: APEX/EPIC Modelling Forum or infer variable meanings by comparison with other files.

**SUGGESTIONS FOR MOVING FORWARD**

**Using the point source input to simulate groundwater baseflow**: I added a point source file (.PSOC and PSOCOM.DAT) in the required format, but it has not been verified well to see if it can simulate the baseflow. This thread also mentions doing something similar: [Point Source Partition Between Runoff and Groundwater Flow](https://groups.google.com/g/agriliferesearchmodeling/c/_My1Kl0gHC4/m/lScdX6DsAAAJ)

You could reach out to them in case they made any progress with it.

**Updating precipitation data to the one from Vredepeel:** The current precipitation data is that from KNMI, Volkel station. Although there are no large differences between the two precipitation datasets, it could be helpful to use the Vredepeel data.

**Further changes in calculation methods used by APEX/ defining additional parameters**: Mostly, the necessary parameters were added but there are multiple optional parameters, the information of which, if added, could be useful to simulate the Dutch conditions. APEX-CUTE is useful but there are some parameters or methods that cannot be tested via APEX-CUTE so it would be a good way forward to test these parameters. For instance, evapotranspiration can be calculated via different methods, so you can check which one would be best suited for this case.

The last section of the APEX User guide has multiple suggestions for validation and calibration. Some other ways can also be found on the Google group.