Data organization

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The present document summarizes the organization of the data for the WHAT-IF model and the HESS publication "WHAT-IF: an open-source decision support tool for water infrastructure investment planning within the Water-Energy-Food-Climate Nexus", it is a complement to the excel files. The data is divided into 5 excel files:

* MainFile: Is the configuration file, specifying the time steps, options and scenarios that are used by the model.
* WaterModule: Data supporting the Water module, including the hydrology (runoff, evapo-transpiration, precipitation, groundwater recharge, catchments …), the reservoirs and the environmental requirements
* AgricultureModule: Data supporting the Agriculture module, including farming zones, farm types, crops and cultures characteristics.
* CropMarketModule: Data supporting the crop market module, including crop markets, demands, value of crops, transport routes and food security constraints.
* EnergyModule: Data supporting the energy production and energy markets modules, including hydropower plants, other power plants, power technologies, fuels, energy markets, demands, value of energy and transmission lines.

The following sections detail all the parameters in the model, as presented in the HESS publication.

# Water module

Table 1: Parameters of the Water module contained in the WaterModule.xlsx file. The parameters are called after their name in the HESS publication, but the name used in the python model is also indicated. The relevant pages of the sources are indicated in the excel files when available.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Notation in publication | Description | Parameter name in model | Excel sheet | Source |
| Indices | | | |  |
| c | Catchments | ncatch | Catchments | - |
| aq | Groundwater aquifers | naquifer | Aquifers | Not used |
| ts | Transfer schemes | ntransfer | TransferSchemes | Not used |
| r | Reservoirs | nres | Reservoirs | (World Bank, 2010) |
| u | Water users | nuser | WaterUsers | (World Bank, 2010) |
| Parameters | | | |  |
|  | Runoff | wRunOff | RunOff | (Cervigni et al., 2015) |
|  | Groundwater recharge | wGwRech | GroundRecharge | Not used |
|  | Rainfall | wRainFall | Precipitation | (Cervigni et al., 2015) |
|  | Reference evapotranspiration | wET0 | ET0 | (Cervigni et al., 2015) |
|  | Water losses in the catchment | wFlowLoss | Catchments | Not used |
|  | Reservoir storage capacity | wResCap | Reservoirs | (World Bank, 2010) |
|  | Volume-Area linear coefficient | wkV | Reservoirs | (World Bank, 2010) |
|  | Volume-Area linear constant | wResArea | Reservoirs | (World Bank, 2010) |
|  | Reservoir outflow coefficient | wAlpha | Reservoirs | Not used |
|  | Groundwater outflow coefficient | wGwFlow | Catchments | Not used |
|  | Transfer scheme loss rate | wTransLoss | TransferSchemes | Not used |
|  | Capacity of the transfer scheme | wTransCap | TransferSchemes | Not used |
|  | Environmental flow requirement | wEnvFlow | EnvFlow | (World Bank, 2010) |
|  | User net water demand | wUserDem | UserDemand | (World Bank, 2010) |
|  | User loss rate | wUserLoss | WaterUsers | (World Bank, 2010) |
|  | User return flow rate | wUserRturn | WaterUsers | (World Bank, 2010) |
|  | Marginal value of water use | wUserVal | WaterUsers | Empirical |
|  | Cost of surface water supply | wSupCost | Aquifers | Not used |
|  | Cost of groundwater water supply | wGwCost | Aquifers | Not used |

# Agriculture production module

Table 2: Parameters of the Agriculture production module contained in the AgricultureModule.xlsx file. The parameters are called after their name in the HESS publication, but the name used in the python model is also indicated. The relevant pages of the sources are indicated in the excel files when available.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Notation in publication | Description | Parameter name in model | Excel sheet | Source |
| Indices |  | | | |
| fz | Farming zones | nfzone | FarmingZones | (World Bank, 2010) |
| ft | Farm types | nftype | FarmTypes | - |
| cr | Crops | ncrops | Crops |  |
| cul | Cultures | nculture | Cultures |  |
| ps | Phases | nyphase | GrowthPhases |  |
| pt | Demand satisfaction paths | nypath | aYieldMat |  |
| Parameters |  | | | |
|  | Land capacity | aLandCap | FarmingZones | (World Bank, 2010) |
|  | Potential yield | aCulYield | Yields | (FAO, 2018) |
|  | Month to phase conversion coefficient | yphase\_month | PhaseMonth | (World Bank, 2010) |
|  | Single crop coefficient | aKc | GrowthPhases | (World Bank, 2010) |
|  | Yield water response factor | aYieldFactor | GrowthPhases | (Doorenbos and Kassam, 1979) |
|  | Cultivation costs | aCulCost | CulCost | (IFPRI, 2015, 2017) |
|  | Irrigation costs | aIrrgCost | FarmingZones | Not used |

# Crop market module

Table 3: Parameters of the Crop market module contained in the CropMarketModule.xlsx file. The parameters are called after their name in the HESS publication, but the name used in the python model is also indicated. The relevant pages of the sources are indicated in the excel files when available.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Notation in publication | Description | Parameter name in model | Excel sheet | Source |
| Indices |  | | | |
| cm | Crop markets | ncmarket | CropMarkets | - |
| cds | Crop demand steps | ncdstep | - | Not used |
| tr | Transport routes | nctrans | CropTransport | - |
| Parameters |  | | | |
|  | Crop demand | aCropDem | CropDem | (FAO, 2018) |
|  | Crop minimum demand | aMinDem | CropMinDem | - |
|  | Crop transport loss rate | aTransLoss | CropTransport | Not used |
|  | Crop marginal value | aCropVal | CropValue | (FAO, 2018) |
|  | Crop external import costs | aCropVal | CropValue | (FAO, 2018) |
|  | Crop transport costs | aTransCost | TransportCost | (FAO, 2018) |

# Energy production module

Table 4: Parameters of the Energy production module contained in the EnergyModule.xlsx file. The parameters are called after their name in the HESS publication, but the name used in the python model is also indicated. The relevant pages of the sources are indicated in the excel files when available.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Notation in publication | Description | | Parameter name in model | Excel sheet | Source |
| Indices | |  | | | |
| hp | Hydropower turbines | | nhpp | Hydropower |  |
| op | Other power plants | | nopp | PowerPlants |  |
| pt | Power technologies | | nptech | PowerTechnologies |  |
| fu | Fuels | | nfuel | Fuels |  |
| Parameters | |  | | | |
|  | Water-Energy equivalent | | eHppProd | Hydropower | (World Bank, 2010) |
|  | Capacity of hydropower turbine | | eHppCap | Hydropower | (World Bank, 2010) |
|  | Efficiency of hydropower plants | | eHppEff | Hydropower | (World Bank, 2010) |
|  | Capacity of other power plants | | eOppCap | PowerPlants | (World Bank, 2010) |
|  | Efficiency of other power plants | | eOppEff | PowerPlants | (IRENA, 2013) |
|  | Lifetime of power technologies | | eLifeTime | PowerTechnologies | (IRENA, 2013) |
|  | CO₂ emission rate of fuels | | eFuelCO2 | FuelCO2 | ? |
|  | Operational costs of hydropower turbines | | eHppCost | Hydropower | (IRENA, 2013) |
|  | Operational costs of other power plants | | eOppCost | PowerPlants | (IRENA, 2013) |
|  | Capital costs of generic technologies | | eCAPEX | PowerTechnologies | (IRENA, 2013) |
|  | Fix operational costs of generic technologies | | eFixOPEX | PowerTechnologies | (IRENA, 2013) |
|  | Variable operational costs of generic technologies | | eVarOPEX | PowerTechnologies | (IRENA, 2013) |
|  | Fuel costs | | eFuelCost | Fuels | (IRENA, 2013) |
|  | CO₂ emission costs | | eFuelCO2 | FuelCO2 | (IRENA, 2013) |

# Energy market module

Table 5: Parameters of the Energy market module contained in the EnergyModule.xlsx file. The parameters are called after their name in the HESS publication, but the name used in the python model is also indicated. The relevant pages of the sources are indicated in the excel files when available.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Notation in publication | Description | Parameter name in model | Excel sheet | Source |
| Indices |  | | | |
| pm | Power markets | npmarket | PowerMarkets | - |
| ls | Load segments | npload | PowerLoads | SAPP |
| Parameters |  | | | |
|  | Power demand | eEngyDem | EnergyDemand | SAPP |
|  | Share of the demand per load segment | eLoadDem | PowerLoads | SAPP |
|  | Length of load segment | eLoadTime | PowerLoads | SAPP |
|  | Load segment capacity factor | eLoadCap | LoadCapacity | (IRENA, 2013) |
|  | Capacity of the transmission line | eTransCap | EnergyTransmission | SAPP |
|  | Power transmission losses | eTransLoss | EnergyTransmission | (IRENA, 2013) |
|  | Local power supply losses | eSupLoss | PowerMarkets | (IRENA, 2013) |
|  | Marginal value of energy | eEngyVal | EnergyValue | Expert assumption |
|  | Energy transmission costs | eTransCost | EnergyTransmission | (IRENA, 2013) |