Scenarios Waterstreams model for GEM 2.2.2

Addendum to Van der Linden *et al*. (2015).
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The document intents to describe the changes in parameterisation of the Waterstreams model made in GEM 2.2.2 as compared to GEM 1.1.1.

The total amount of discharge of the scenarios described in Van der Linden *et al*. (2015) corresponds to the allowed nitrogen discharge in kg per ha per year according to the Activiteitenbesluit (2012) for the four scenario crops that represent all other soilless grown crops (see Table 1). The reference period used was 2015-2017. In GEM 2.2.2, in addition to the reference period 2015-2017, also the reference period 2018-2020 was added.

Table 1: Allowed nitrogen discharge (kg/ha/yr) and corresponding amount of water (m^3/ha/yr) with nutrients for chosen crops in different periods.

Crop	Allowed discharge 2012 -2014		Allowed discharge 2015 -2017		Allowed discharge 2018 -2021	
	N	water	N	water	N	water
Tomato	125	300	83	200	67	150
Pepper	200	650	133	425	100	325
Ficus	150	900	100	600	75	450
Rose	250	1050	167	700	125	525

With the Waterstreams model the amount of discharge distributed over the year is calculated. Normally the Waterstreams model is used to estimate discharge volumes due to accumulation of sodium and to show the sensitivity to various parameters that affect the sodium accumulation (e.g. amount of sodium in supply water, size of rainwater collection tank, use of water sources and sodium uptake per crop). Growers may need to discharge for technical reasons, such as accumulation of sodium, filter rinsing water, leakage and management reasons, such as unsatisfactory growth or restart with a fresh nutrient solution. Together, technical and management reasons cause a considerable variability in the amounts of discharge.

For the scenario derivation, discharge was the starting point of the parameterisation of the Waterstreams model. A scenario should represent realistic worst case conditions for a reference period.
In Van der Linden *et al*. (2015) a general description of the Dutch soilless greenhouse cultivation is given. However, the given parameterisation is too optimistic for the realistic worst case situation (the 90th percentile situation). As a consequence, using the given parameters in the Waterstreams model, calculated discharge volumes are lower than the values in Table 1. In order to realise scenarios compatible with the emission values given in Table 1, input parameters for the Waterstreams were adjusted: volume of rainwater basin, sodium contents of water sources and the volume passing the filter between to cleansing operations.
In Table 2 an overview is given of the parameters to be used in the Waterstreams model according Van der Linden et al. (2015).

Table 2: Parameters Waterstreams model compatible with the general description.

Parameter	Unit	Crop			
		Tomato	**Pepper**	**Ficus**	**Rose**
Rainwater (priority 1)	mmol/l	0.1	0.1	0.1	0.1
Reverse Osmosis water (2)	mmol/l	0.1	0.1	0.1	0.1
Surface water (5)	mmol/l	1.5	1.5	1.5	1.5
Groundwater (4)	mmol/l	0.5	0.5	0.5	0.5
Tapwater (3)	mmol/l	1.5	1.5	1.5	1.5
Capacity rainwater basin	m^3/ha	1500	1500	1500	1500
Starting content basin	m^3/ha	1500	1500	1500	1500
Mix tank	m^3/ha	25	25	25	25
Substrate	m^3/ha	150	150	250	150
Substrate start	m^3/ha	100	100	200	100
Leakage	%	1.5	1.5	1.5	1.5

Draintank	m^3/ha	50	50	50	50
Condenswater recycled	%	80	80	80	80
Osmosis	m^3/ha/d	60	60	60	60
Osmosis start	Day no	91	91	91	91
Osmosis end	Day no	237	237	244	237
Osmosis start/end		25% empty/ 75% full	25% empty/ 75% full	25% empty/ 75% full	25% empty/ 75% full
Recipe NO_3	mmol/l	10.75	12.5	10.5	4.3
Uptake NO_3	mmol/l	10.5	9.7	d	5.5
Na uptake	mmol/l	0.06	0.01	0.02	0.001
Discharge strategy	Draintank	Full	Fraction	Fraction	Daily drain
Filter rinsing source/goal		Draintank/ discharge	Draintank/ discharge	Draintank/ discharge	Draintank/ discharge
Na threshold	mmol/l	8	6	5	4
Drain	%	30	30	50	50
Filter cleaning after each supply volume of water	m^3/ha	16.2	5.1	9.9	9.8
Filter discharge volume	m^3	1.63	1.63	1.63	1.63

In GEM 2.2.2 the following changes in the parameterisation of the Waterstreams model have been made to the scheduled discharge amounts (Table 1):

- Rainwater basin size was decreased from 1500 to 500 m^3/ha. This means that earlier in the season another water source has to be used, in this case reverse osmosis and with a higher sodium concentration.
- Filter rinsing water can be discharged, which is currently common practice. It is also possible to recirculate the filter rinsing water. The Waterstreams model was parameterised for both options:
    - When the filter rinsing water is discharged, the volume of filter rinsing water is related to the amount of water supplied and a high frequency of discharge during the year will be achieved. So a high transpiring crop has more filter rinsing water than a low transpiring crop. The parameters in the Waterstreams model were set such that the total volumes discharged were met. For example, for tomato the set point was that filter rinsing starts after each 16.2 m^3 water supplied to the plants per ha (see Table 2). To achieve the target discharge volume for 2012-2014, the amount of filter rinsing water was set to a value of 1.63 m^3/ha. For 2015 – 2017 the target discharge volume was lower and the filter cleansing required less frequent than for 2012-2014: 26.0 m^3/ha. After 2017 only filter rinsing was needed after each 32.8 m^3/ha of water supplied to the plants, as summarised in the list below:
        - Tomato: 16.2 → 26.0 → 32.8 m^3/ha supply after which filter rinsing is required
        - Pepper: 5.1 → 8.9 → 12.7
        - Ficus: 9.5 → 16.5 → 23.8
        - Rose: 9.8 → 17.5 →26.0
    - When filter rinsing water is recirculated, there is less frequent discharge. However, due to water quality reasons their might be an accumulation of sodium which will be reason to discharge again but less frequent.

  With these settings, the Waterstreams model generates the water flows in the various scenarios and these are input to the substance fate model.

References

Anonymous. 2012. Activiteiten Besluit Milieubeheer. Besluit van 14 september 2012 tot wijziging van het Besluit algemene regels voor inrichtingen milieubeheer.

Van der Linden, A.M.A., E.A. van Os, E.L. Wipfler, A.A. Cornelese, D.J.W. Ludeking, T. Vermeulen, 2015. Scenarios for exposure of aquatic organisms to plant protection products in the Netherlands. Soilless cultivations in greenhouses. RIVM report 607407005, Bilthoven, the Netherlands.