Risk Assessment for Protected Crops – Approaches Towards Harmonized Leaching Scenarios (GASP-S v1.1)

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Introduction and Objective

Groundwater assessment in protected crops is driven by several factors, such as temperature, evapotranspiration, and irrigation. Irrigation scheduling plays an important role in greenhouse cultivation, since under-irrigation results in yield losses, and over-irrigation triggers susceptibility of the crop to diseases and provokes nutrient loss (Pardossi and Incrocci, 2011). The recently published EFSA guidance on protected crops (EFSA, 2014) provides recommendations on exposure assessment in protected crops in the regulatory context. Our previously proposed scenario definitions (GASP-S v1.0, Sittig et al., 2015) were further developed for an improved account of management strategies and crop definition.

Materials and Methods

Figure 1 shows an overview of the dependencies in the derived GASP-S scenarios.

- **Soil definition, air temperature, radiation and evapotranspiration (ETref):** individual FOCUS soil definitions; air temperature unchanged from Sevilla scenario; ET_{ref} estimated, using Hargreaves transformation, as proposed in Fernandez et al., (2010)
- **Crop:** tomato long-cycle (16.08. – 30.05; Fig. 2)
- **Management practices:** irrigation based on the actual plant demand, calculated as ET_{ref} * k_c (Pardossi and Incrocci, 2011) + 20% over-irrigation (EFSA, 2014), including irrigation pre-transplant and for disinfection/ solarization

Changes compared to v1.0

- Soils Hamburg and Châteaudun added
- Tomato crop definition updated according to irrigation software PrHo (Fernández et al., 2008), as depicted in Fig. 2
- Management practices refined: soil covered by plane (e.g. poly-ethylene) for solarization, resulting in zero evapotranspiration (21.06. – 25.07.); irrigation for disinfection/solarisation adapted

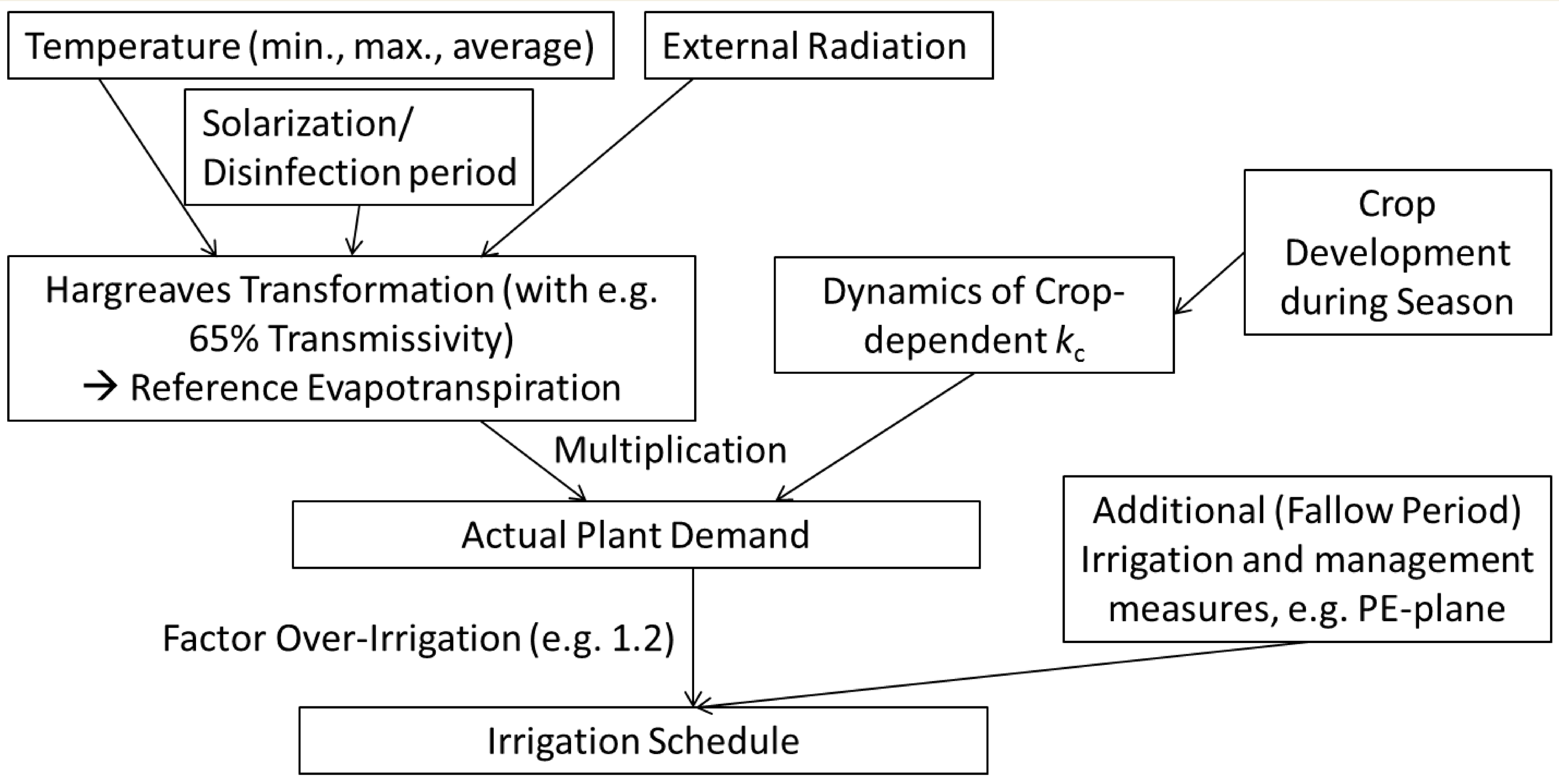

Figure 1: Dependencies in the derived scenarios leading toward the applied irrigation scheme.

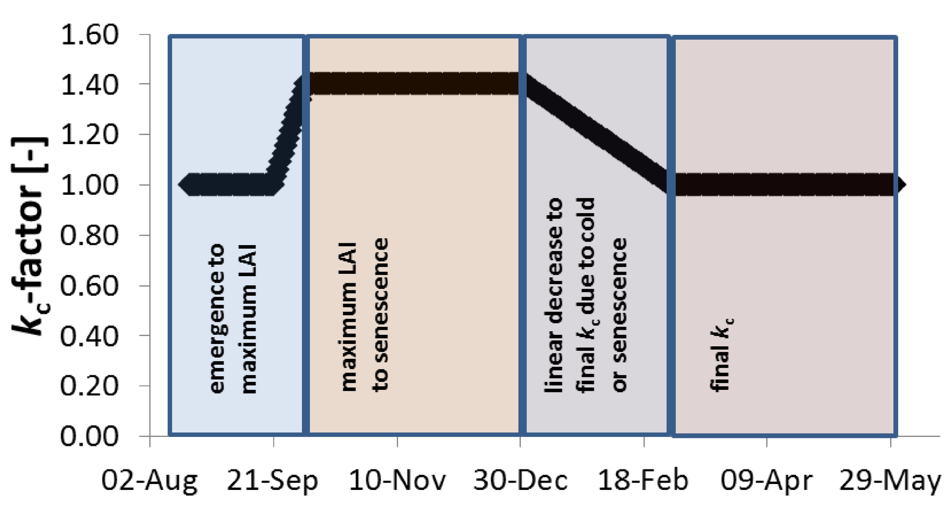

Figure 2: Dynamics of the annual crop development factor k_c, in combination with the leaf area index (LAI).

Table 1: Mean annual irrigation amounts and recharges in Southern European greenhouses

	Irrigation during cropping [mm]	Percental recharge in 1 m
GASP-S v1.0 (Sevilla)	388	18
GASP-S v1.1	431	15
Reported amounts	363 – 502*	-

* Fernández et al., 2007: mean annual irrigation in typical crops in the Almería region

** Gallardo et al., 2013

Results & Discussion

The proposed scenario was validated by checking the following criteria:

- ✓ The total irrigation amount is within the range of typical Mediterranean greenhouses (Table 1).
- ✓ During the whole cropping period, the proposed irrigation regime ensured a pressure head within the optimum range of -100 to -300 cm (Fundacion Cajamar, 2005) (Fig. 4).
- ✓ The recharge fraction is within the range of 10 - 20% of irrigation, which avoids salinization while maintaining water use efficiency. This is in the range of the FOCUS field approach and the EFSA example scenario (Table 1). Analogous results were obtained for all Southern European greenhouse scenarios and the FOCUS soils Hamburg and Châteaudun (not shown).

Our greenhouse assessment leads to lower PECgw, compared to the standard field procedure in all cases under investigation (Fig. 3 for FOCUS standard substances B and C metabolite). This is a plausible outcome, considering the controlled irrigation conditions in greenhouses which limit leaching losses. Version 1.1 does not result in systematically lower or higher PECgw than v1.0, this comparison depends on location and application date.

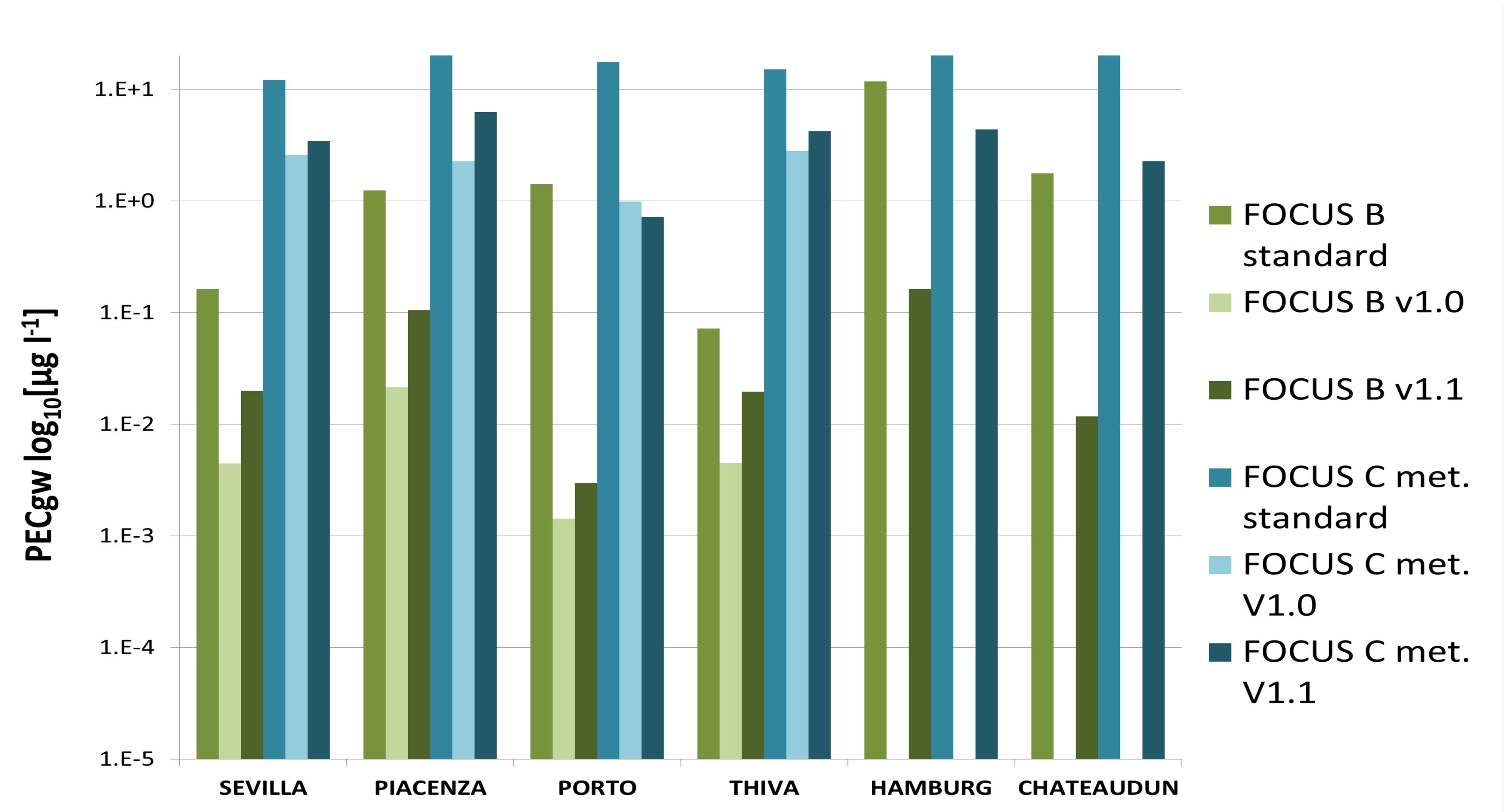

Figure 3: PECgw resulting from simulations using GASP-S v1.0, v1.1, or standard FOCUS field modeling procedure (1 * 1 kg ha^{-1} , 1 week after transplant).

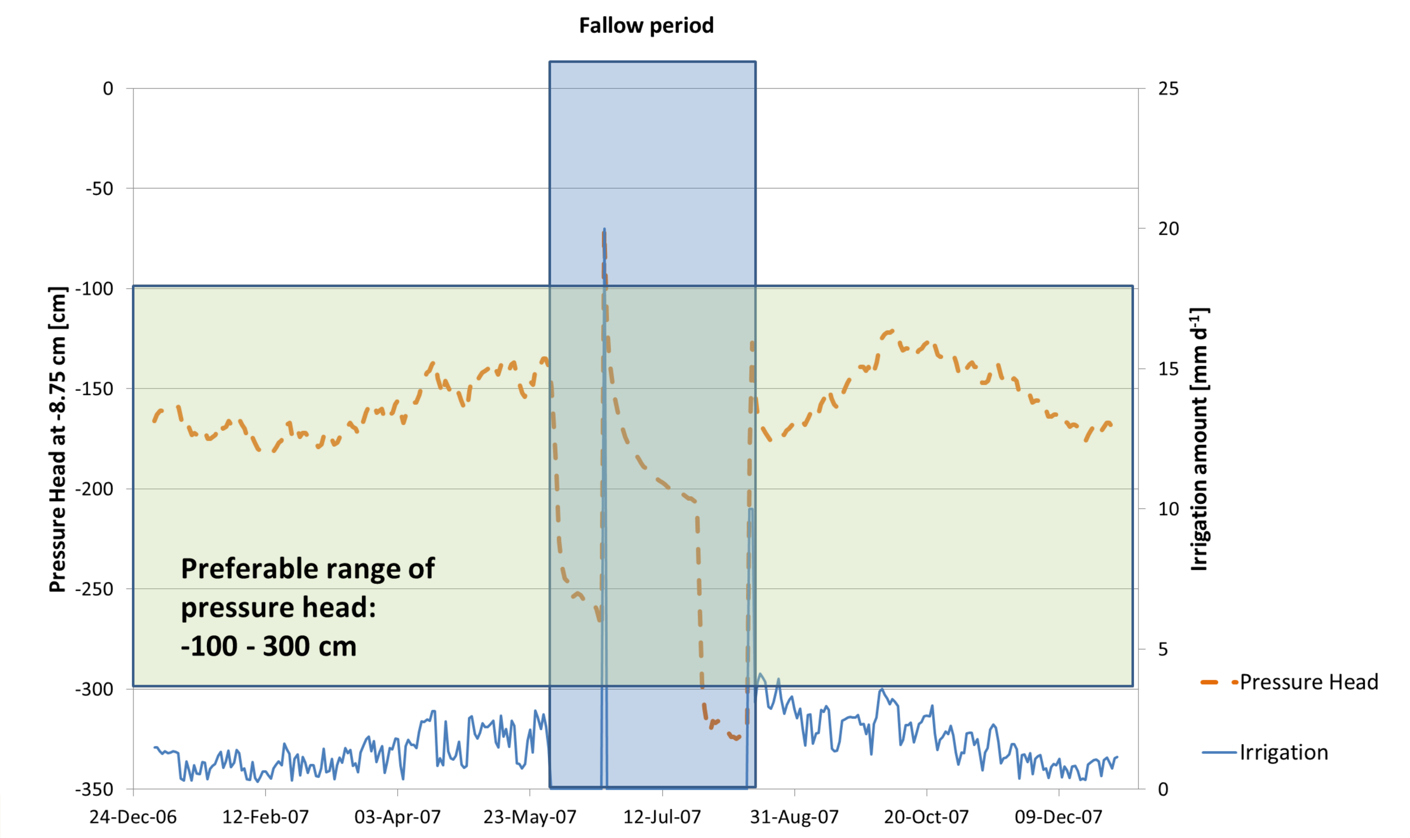

Figure 4: Dynamics of pressure head and daily irrigation amounts for greenhouse tomatoes in FOCUS Sevilla soil - (FOCUS PEARL 4.4.4).

Conclusions

The proposed methodology for evapotranspiration and irrigation produces a scenario that matches the criteria as laid down in the ESFA guidance and meets the validation criteria defined above (%-tage recharge; optimal wetting conditions; total irrigation amount). The further improved GASP-S scenarios (v1.1) provide a suitable basis for leaching assessment in Southern European greenhouses and walk-in tunnels, integrating expert knowledge from users.

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