Supplementary Material

Do digital twins need people? Integration of the human dimension into digital twins of the natural environment

Table A: Analysis of the inclusion of human component, scale and study area of digital twins of the natural environment found in the literature.

References	Study area	Status	Scale	Human component
Alves et al. (2023)	agriculture	prototype	local	no
Angin et al. (2020)	agriculture	architecture	local	no
Bauer et al. (2021)	earth systems	proposed	supra-regional	yes, partial, proposed
Buonocore et al. (2022)	environment	framework	local	no
Calvin & Bond-Lamberty (2018)	earth systems	proposed	supra-regional	yes
Chaux et al. (2021)	agriculture	framework	local	no
Chen et al. (2023)	environment - water	prototype	local	no
Davis et al. (2023)	environment	architecture	local	no
Defraeye et al. (2021)	agriculture	proposed	supra-regional	no
Delgado et al. (2019)	agriculture	framework	regional	no
Gettelman et al. (2022)	earth systems	proposed	supra-regional	no
Knibbe et al. (2022)	environment	prototype	regional	no
de Koning et al. (2023)	environment	proposed	local	no
Bye et al. (2022)	environment	prototype	regional	no
Mishra & Sharma (2023)	agriculture	proposed	local	no
Moghadam et al. (2020)	agriculture	prototype	local	no
Monteiro et al. (2018)	agriculture	prototype	local	no
Moreira et al. (2021)	environment - water	framework	regional	no
Moshrefzadeh et al. (2020)	agriculture	framework	local	no
Nativi et al. (2021)	earth systems	architecture	supra-regional	no
Niță (2021)	environment	framework	local	no
Neethirajan & Kemp (2021)	agriculture	proposed	local	no
Park & You (2023)	environment - water	prototype	regional	no
Qiu et al. (2022)	environment - water	prototype	regional	no
Raba et al. (2022)	agriculture	prototype	local	no

References	Study area	Status	Scale	Human component
H. Rand (2019)	urban - water	prototype	local	no
Tsolakis et al. (2019)	agriculture	prototype	local	no
Verdouw et al. (2021)	agriculture	proposed	local	no
T. Zhang et al. (2020)	environment	prototype	regional	no

Remarks

- Local: farm, lake, park, city, etc.
- Regional: multiple farms, cities, water systems, national, etc.
- Supra-regional: international, continental, or global

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