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Urban SIS
D5.4.1 Proposal for KPIs

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Edited by: SMHI (Jonas Olsson, WP5 leader)

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Introduction

Key Performance Indicators (KPIs) will be used to measure the performance of the Urban SIS proof-of-concept project. The KPIs will be defined to reflect the amount and usefulness of output expected to be available after the project. In order for the output to contribute to the KPIs, it should also comply with certain quality criteria that must be possible to verify and monitor for each city. The KPIs should give an idea about the feasibility of the Urban SIS output, its quality and usefulness.

In the Copernicus Climate Change Services, KPIs will be considered as dynamical parameters, e.g. with different formulations for the proof-of-concept phase and the subsequent operational phase. This report focus on KPIs for the proof-of-concept phase, and during this phase KPIs for the operational phase will be developed (see further below).

KPI structure

We divide the KPIs into the following three types:

- *KPIs for Essential Climate Variables (ECVs)*. ECVs are the primary type of data produced in Urban SIS, describing meteorological, air quality and hydrological conditions at high temporal and spatial resolutions in and around each city. These KPIs describe the number of ECVs.
- *KPIs for impact indicators*. The impact indicators are calculated from the ECVs and represent different meteorological, air quality and hydrological hazards. These KPIs describe the number of impact indicators.
- *KPIs for end-user applications*. The ECVs and impact indicators will be applied and evaluated in modelling and assessment by various end-users involved in Urban SIS. These KPIs describe the extent of these activities.

KPIs for Essential Climate Variables (ECVs)

The first type of KPIs is intended to quantify the number of qualified ECVs. "Qualified" implies that the ECV fulfills the requirements described in the following.

- The downscaled urban ECV data for a historical period have been evaluated against observations. As relevant observations for the comparison are not always available, evaluation will not be possible for all ECVs. The evaluation methods and results will be reported in D5.1-3 Validation reports. A preliminary overview of available observations is given in Appendix 1.
- The ECV is accompanied by metadata fulfilling general requirements. See further section Metadata below.
- The ECV can be downloaded from the Urban SIS portal (linked from CDS portal) with verified functionality.

Separate KPIs will be produced for the three ECV categories included in Urban SIS: meteorology, air quality and hydrology. Table 1 below contains the ECVs in the different categories and the KPI target values. Target values are estimated from the availability of measurement stations in Bologna and Stockholm, but all possibilities to raise the numbers above the target value should be considered.

Table 1. KPIs for ECVs

KPI nr.	Category	ECVs	Target value
1a	Meteorology	Air temperature Precipitation Relative humidity Wind Boundary layer height Snowfall Global radiation Direct shortwave radiation Diffuse shortwave radiation	5
1b	Air quality	O3 concentration NO2 concentration PM10 concentration PM2.5 concentration	2
1c	Hydrology	Local runoff Surface runoff Evapotranspiration River discharge Soil moisture Snow cover	2

KPIs for impact indicators

The second type of KPIs is intended to quantify the number of qualified impact indicators. "Qualified" implies that the indicator fulfills the requirements described in the following.

- The relevance of the indicator has been explicitly confirmed by at least one end-user involved in Urban SIS. A tentative gross list of impact indicators has been produced and presented at end-user workshops. The final list will be reported in D4.3 Impact indicators for use in urban assessments, where also the explicit confirmation of relevance by end-users will be reported. A list of end-users attending the workshops in Stockholm and Bologna is given in Appendix 2.
- The indicator is accompanied by metadata fulfilling general requirements. See further section Metadata below.
- The indicator can be downloaded from the Urban SIS portal (linked from CDS portal) with verified functionality.

Separate impact indicators will be produced for the four indicator categories included in Urban SIS: meteorology/infrastructure, meteorology/health, air quality/health and hydrology/infrastructure. Table 2 below contains the estimated (gross) number of indicators estimated in the different categories and the KPI target values.

Table 2. KPIs for impact indicators

KPI nr.	Category	Gross nr. of indicators	Target value
2a	Meteorology/infrastructure	5-10	3
2b	Meteorology/health	10-15	4
2c	Air quality/health	5-10	3
2d	Hydrology/infrastructure	5-10	2

KPIs for end-user testing

The third type of KPIs is related to the testing and assessment of the developed products during the proof-of-concept phase of Urban SIS. Comprehensive testing is important to verify the applicability of the products in real-life cases and we define two KPIs of this type.

- *Number of data downloads*. This is a very direct measure of the activity of the project's end-users with respect to actually using the systems developed and applying the data produced. Separate KPIs will be produced for ECVs and impact indicators.
- *Number of assessments made based on Urban SIS data*. An assessment is defined as an impact study focusing on one specific issue made by at least one specific end-user in one specific location involving at least one ECV or impact indicator. As an example, one assessment may focus on future flood risk (issue) made by the consulting company WSP (end-user) in Stockholm (location) using precipitation (ECV) from Urban SIS.

Table 3 contains the KPIs and their target values.

Table 3. KPIs for end-user testing

KPI nr.	Category		Target value
3a	Number of data downloads	ECV	8
3b	Number of data downloads	Impact indicators	8
3c	Number of assessments		4

Metadata

Metadata have the objective to allow end-users to fully understand the Urban SIS ECVs and impact indicators. Metadata for each demonstration city will be available on the Urban SIS portal under the following structure:

- *Meteorological ECVs* (Table 4a,b)
  - Historical period
  - Climate scenario
- *Air quality ECVs* (Table 5a,b)
  - Historical period
  - Climate scenario
- *Hydrological ECVs* (Table 6a,b)
  - Historical period
  - Climate scenario
- *Meteorology/infrastructure impact indicators* (Table 7)
- *Meteorology/health impact indicators* (Table 8)
- *Air quality/health impact indicators* (Table 9)
- *Hydrology/infrastructure impact indicators* (Table 10)

Air quality and hydrological ECVs both use the meteorological model results as input, thus the metadata related to meteorology will not be repeated under the air quality and hydrological metadata.

The metadata available under the listed structure will consist of tables to allow an easy overview of the most important characteristics. Within the metadata tables there will also be references to Urban SIS deliverables – also available on the Urban SIS portal - where more details can be found. As an example downscaling will be documented in D3.1-6, validation D5.1-3, end-user requirements in D.4.2-3 and performed assessments based on Urban SIS output in eight separate WP6 deliverables.

Table 4a. Metadata for Meteorological ECVs (downscaled historical period)

Characteristics	Example (Bologna)
domain	165x180 km^2
spatial / temporal resolution	1x1 km^2 / hourly
period	Jan 2006 – Dec 2010
downscaling model	HARMONIE cy40h1.1
forcing/boundary conditions	UERRA re-analysis over Europe with HARMONIE (11x11 km^2) (*add possible link to this data set*)
urban canopy model	SURFEX 7.3
land use	ECOCLIMAP II updated with Urban Atlas 2012
downscaling details	Urban SIS D3.1 Urban climate ECV and impact indicator data for historical conditions
validation	Urban SIS D5.1 Validation of climate variables

Table 4b. Metadata for Meteorological ECVs (downscaled climate scenario)

Characteristics	Example (Bologna)
domain	185x190 km2
spatial / temporal resolution	1x1 km2 / hourly
period 1 ("present climate")	2006-2010
period 2 ("future climate")	2055-2060
downscaling model	HARMONIE cy40 (climate mode)
forcing/boundary conditions	HARMONIE regional climate model over Europe (6x6 km2), forced by GCM EC_Earth output (T511 ~40x40km2). The GCM future scenario 2055-2085 is centered around a temperature increase of 4 degrees (SWL4) and driven by emission scenario RCP8.5 (add possible links to the RCM and GCM data sets)
urban canopy model	SURFEX 7.3
land use period 1 and 2	ECOCLIMAP II updated with Urban Atlas 2012 (held constant also for the "future" period 2)
downscaling details	Urban SIS D3.4 Urban climate ECV and impact indicator data for future conditions

Table 5a. Metadata for Air Quality ECVs (downscaled historical period)

Characteristics	Example (Bologna)
domain	165x180 km2
spatial / temporal resolution	1x1 km2 / hourly
period	Jan 2006 – Dec 2010
downscaling model	MATCH (version as in CAMS-50)
forcing/boundary conditions	MATCH simulation over EUROPE with TNO MACC-III emissions and UERRA/HARMONIE meteorology (Table 4a).
land use and surface conditions	As given by SURFEX in the HARMONIE downscaling (Table 4a)
urban emissions	SOx/NOx/NMVOC/CO/NH4/PM emissions provided by ARPAE on a 1x1 km2 resolution, valid for 2012 (add possible link to data set or document)
downscaling details (also on urban emissions)	Urban SIS D3.2 Urban air quality ECV and impact indicator data for historical conditions
validation	Urban SIS D5.2 Validation of air quality variables

Table 5b. Metadata for Air Quality ECVs (downscaled climate scenario)

Characteristics	Example (Bologna)
domain	185x190 km2
spatial / temporal resolution	1x1 km^2 / hourly
period 1 (“present climate”)	2006-2010
period 2 (“future climate”)	2055-2060
downscaling model	MATCH (version as in CAMS-50)
forcing/boundary conditions	MATCH simulation over EUROPE with IIASA CLE-projected emissions 2050 based on TNO MACC-III spatial distributions and HARMONIE SLW4/RCP8.5 climate scenario forcing (Table 4b).
land use and surface conditions period 1 and 2	As given by SURFEX in the HARMONIE downscaling (Table 4b)
urban emissions period 1 and 2	SOx/NOx/NMVOC/CO/NH4/PM emissions provided by ARPAE on a 1x1 km2 resolution, valid for 2012 SOx/NOx/NMVOC/CO/NH4/PM projected emissions for 2050 provided by ARPAE on a 1x1 km2 resolution
downscaling details (also on urban emissions)	Urban SIS D3.5 Urban air quality ECV and impact indicator data for future conditions

Table 6a. Metadata for Hydrological ECVs (historical period)

Characteristics	Example (Bologna)
domain	X km2
period	Jan 2006 – Dec 2010
downscaling model	HYPE v. X
forcing/boundary conditions	UERRA/HARMONIE meteorology (Table 4a).
number and area of catchments	X sub-catchments of mean size X km²
topography/routing	Hydrosheds and Hydro 1k
land use in catchment areas	Urban Atlas 2012, CORINE
soil type in cathment areas	Based on land use data and elevation
lake information	GLWD (Global Lake and Wetland Database)
downscaling details	Urban SIS D3.3 Urban hydrological ECV and impact indicator data for historical conditions
validation	Urban SIS D5.3 Validation of hydrological variables

Table 6b. Metadata for Hydrological ECVs (climate scenario)

Characteristics	Example (Bologna)
domain	X km2
period 1 ("present climate")	2006-2010
period 2 ("future climate")	2055-2060
downscaling model	HYPE v. X
forcing/boundary conditions	UERRA/HARMONIE meteorology (Table 4a)
number and area of catchments	X sub-catchments of mean size X km²
topography/routing	Hydrosheds and Hydro 1k
land use in catchment areas	Urban Atlas 2012, CORINE
soil type in cathment areas	Based on land use data and elevation
lake information	GLWD (Global Lake and Wetland Database)
downscaling details	Urban SIS D3.3 Urban hydrological ECV and impact indicator data for historical conditions
validation	Urban SIS D5.3 Validation of hydrological variables

Table 7. Metadata for Meterology/infrastructure impact indicators

impact indicators	Description (examples)
Valid for periods	2006-2010 (historical), 2006-2010 ("present climate") and 2055-2060 ("future climate")
Dry days per year	Mean and maximum number of consecutive dry days on yearly/ seasonally basis
Days with intense precipitation (per year)	Number of events when a given threshold is exceeded. Thresholds are considered as rainfall intensities computed as the 90th percentile of a climatological period. Significant durations for urban drainage/ flooding purposes are 1h, 3h, 6h, 12h, 24h. NOTE: Any information regarding sub-hourly intensities would be extremely valuable.
….	
….	
details	Urban SIS D4.3 Impact indicators for use in urban assessments

Table 8. Metadata for Meterology/health impact indicators

impact indicators	Description (examples)
Valid for periods	2006-2010 (historical), 2006-2010 (“present climate”) and 2055-2060 (“future climate”)
Heat wave days per year	Number of days above temp T for N days in a row. Percentiles of daily max (and daily mean) 75, 90, 95 duration > 2 days Days per year for each of the thresholds.
Heat wave duration (days)	The maximum number of consecutive days with maximum temperature greater than 90th daily percentile
Thom discomfort index (days per year)	Number of days exceeding the defined thresholds (24 and 28 Thom index)
….	
….	
details	Urban SIS D4.3 Impact indicators for use in urban assessments

Table 9. Metadata for Air quality/health impact indicators

impact indicators	Description (examples)
Valid for periods	2006-2010 (historical), 2006-2010 (“present climate”) and 2055-2060 (“future climate”)
Concentration of PM2.5 (average)	Concentration of PM2.5, to be compared to EU limit value 40 µg/m3.
Daily values above of EU PM10 limit value (days per year)	Numer of days with daily values of PM10 above EU PM10 limit value 35 days/year.
PM2.5: Mortality, age 30+ years, long-term exposure (deaths per year)	Calculated with population data from 2012 and with exposure-response coefficient (RR) 1.062 (95% CI 1.040-1.083) per 10 µg/m3 (WHO, 2013).
…	
….	
details	Urban SIS D4.3 Impact indicators for use in urban assessments

Table 10. Metadata for Hydrology/infrastructure impact indicators

impact indicators	Description (examples)
Valid for periods	2006-2010 (historical), 2006-2010 (“present climate”) and 2055-2060 (“future climate”)
IDF curves	Estimation of extreme rainfall for 1, 5, 10, 20, 50, 100 years return periods and for 0.25, 1, 2, 3, 6, 12, 24 h durations.
Areal Reduction Factors	Describing how the extreme intensity decreases with increasing area for different combinations of return periods and durations.
Days with intense precipitation	Number of events when a given threshold is exceeded. Thresholds are considered as rainfall intensities computed as the 90th percentile of a climatological period. Significant durations for urban drainage/ flooding purposes are 0.25h, 1h, 3h, 6h, 12h, 24h.
…	
….	
details	Urban SIS D4.3 Impact indicators for use in urban assessments

KPIs for the operational phase

Suggested KPIs for the operational phase, following the ongoing proof-of-concept phase, will be given in report D5.4.2. These KPIs should reflect user uptake (e.g. number of cities), different aspects of system scalability, etc.

Summary and follow-up

All KPIs target values are listed in Table 11. This table will be given in an updated form in Quarterly reports, Annual reports and the final result given in the D1.3 Final report.

Table 11. KPIs follow-up table at 29/02/2016

KPI nr.	Target value	Current status	Comments
1a	5	0	
1b	2	0	
1c	2	0	
2a	3	0	
2b	4	0	
2c	3	0	
2d	2	0	
3a	8	0	
3b	8	0	
3c	4	0	

Appendix 1: ECV validation data

Meteorology

BOLOGNA					
ECV	Area	Number of stations etc.	Time resolution	Data period	Owner
Air temperature	Inside city	2	hourly	2005-now*	ARPAE Emilia Romagna
a), b)	Outside city	60	daily	1971-now	ARPAE Emilia Romagna
Precipitation - gauge	Inside city	3	Daily, hourly and 15 min	1971-now**	ARPAE Emilia Romagna
c), d)	Outside city	250	daily	1971-now	ARPAE Emilia Romagna
Precipitation - radar	Inside city	0			
	Outside city	2	5 min	1994-now***	ARPAE Emilia Romagna
Relative humidity	Inside city	1	hourly	2005-now	ARPAE Emilia Romagna
a)	Outside city	68	hourly	2001-now	ARPAE Emilia Romagna
Wind	Inside city	1	hourly	2005-now	ARPAE Emilia Romagna
a)	Outside city	35	hourly	2001-now	ARPAE Emilia Romagna
Boundary layer height	Inside city	0			
	Outside city	1	hourly	2012 - 2014	ARPAE Emilia Romagna
Snowfall	Inside city	1	daily	1971-now****	ARPAE Emilia Romagna
	Outside city	21	daily	1971-now*****	ARPAE Emilia Romagna
Global radiation	Inside city	1	hourly	2005-now	ARPAE Emilia Romagna
a)	Outside city	32	hourly	2001-now	ARPAE Emilia Romagna
Direct shortwave rad.	Inside city	1	hourly	2005-now	ARPAE Emilia Romagna
	Outside city	9	hourly	2005-now	ARPAE Emilia Romagna
Diffuse shortwave rad.	Inside city	1	hourly	2005-now	ARPAE Emilia Romagna
	Outside city	9	hourly	2005-now	ARPAE Emilia Romagna
STOCKHOLM					
ECV	Area	Number of stations etc.	Time resolution	Data period	Owner
Air temperature	Inside city	2 (Observatoriekullen, KTH)	hourly	from 1996 (kullen)...	SMHI
	Outside city	2 (Bromma, Arlanda)	hourly		SMHI
Air temperature	Inside city	2 (Torkel, Högdalen)	hourly	2006=>	Slb
	Outside city	3 (N Malma, Uppsala-Märsta, Eskilstuna)	hourly	2006=>	Slb
Precipitation - gauge	Inside city	1 (SMHI), ? (SV)	15-min	1996-now	SMHI
	Outside city	~10 (SMHI)	15-min	1996-now	SMHI
Precipitation - radar	Inside city	2x2 km	5-min	2000-now	SMHI
	Outside city	2x2 km	5-min	2000-now	SMHI
Relative humidity	Inside city	2 (Observatoriekullen, KTH)	hourly	from 1996 (kullen)...	SMHI
	Outside city	2 (Bromma, Arlanda)	hourly		SMHI
Relative humidity	Inside city	2 (Torkel, Högdalen)	hourly	2006=>	Slb
	Outside city	3 (N Malma, Uppsala-Märsta, Eskilstuna)	hourly	2006=>	Slb
Wind	Inside city				
	Outside city	2 (Bromma, Arlanda)	hourly		SMHI
Wind	Inside city	2 (Torkel, Högdalen)	hourly	2006=>	Slb
	Outside city	3 (N Malma, Uppsala-Märsta, Eskilstuna)	hourly	2006=>	Slb
Boundary layer height	Inside city				
	Outside city				
Snowfall	Inside city				
	Outside city				
Global radiation	Inside city	1 (Stockholm KTH)	hourly	sedan 2013 endast!	SMHI
	Outside city				
Global radiation	Inside city	2 (Torkel, Högdalen)	hourly	2006=>	Slb
	Outside city	3 (N Malma, Uppsala-Märsta, Eskilstuna)	hourly	2006=>	Slb
Direct shortwave rad.	Inside city				
	Outside city				
Diffuse shortwave rad.	Inside city				
	Outside city				

Air quality

BOLOGNA					
ECV	Area	Number of stations etc.	Time resolution	Data period	Owner
O3 concentration	Inside city	2	hour	from 2001	ARPAE Emilia Romagna
	Outside city	15	hour	from 2001	ARPAE Emilia Romagna
NO2 concentration	Inside city	4	hour	from 2001	ARPAE Emilia Romagna
	Outside city	20	hour	from 2001	ARPAE Emilia Romagna
PM10 concentration	Inside city	4	day	from 2006	ARPAE Emilia Romagna
	Outside city	15	day	from 2006	ARPAE Emilia Romagna
PM2.5 concentration	Inside city	2	day	from 2009	ARPAE Emilia Romagna
	Outside city	10	day	from 2009	ARPAE Emilia Romagna
STOCKHOLM					
ECV	Area	Number of stations etc.	Time resolution	Data period	Owner
O3 concentration	Inside city	1 (Torkel)	hourly	2006=>	Slb
	Outside city	2 (N Malma, Aspvreten)	hourly	2006=>	Slb
NO2 concentration	Inside city	1 (Torkel)	hourly	2006=>	Slb
	Outside city	1 (N Malma)	hourly	2006=>	Slb
PM10 concentration	Inside city	1 (Torkel)	hourly	2006=>	Slb
	Outside city	2 (N Malma, Aspvreten)	hourly	2006=>	Slb
PM2.5 concentration	Inside city	1 (Torkel)	hourly	2006=>	Slb
	Outside city	2 (N Malma, Aspvreten)	hourly	2006=>	Slb
PM10 concentration	Inside city				
	Outside city	1 (Uppsala)	daily	några år	IVL
PM2.5 concentration	Inside city	1 (Stockholm)		några år	
	Outside city	1 (Uppsala)	hourly	några år	Slb

Hydrology

BOLOGNA					
ECV	Area	Number of stations etc.	Time resolution	Data period	Owner
Local runoff	Inside city	???			
	Outside city	???			
Surface runoff	Inside city	???			
	Outside city	???			
Evapotranspiration	Inside city	2 (A)	daily	1971-now	ARPAE Emilia Romagna
(B, C)	Outside city	60	daily	2001-now	ARPAE Emilia Romagna
River discharge	Inside city	1	30 min/1 hour	2012-now	ARPAE Emilia Romagna
	Outside city	1	30 min/1 hour	1993-now	ARPAE Emilia Romagna
Soil moisture	Inside city	0			
(D)	Outside city	10	daily	2001-now	ARPAE Emilia Romagna
Snow cover	Inside city	(E)	variable: from daily to 15	2005-now	ARPAE Emilia Romagna
	Outside city	(E)	variable: from daily to 15	2005-now	ARPAE Emilia Romagna
STOCKHOLM					
ECV	Area	Number of stations etc.	Time resolution	Data period	Owner
Local runoff	Inside city				
	Outside city				
Surface runoff	Inside city				
	Outside city				
Evapotranspiration	Inside city				
	Outside city				
River discharge	Inside city	?	?	?	Stockholm Vatten
	Outside city	~15	various	various	SMHI
Soil moisture	Inside city				
	Outside city				
Snow cover	Inside city	1	daily	2013-now	
	Outside city	2	daily	2013-now	

Appendix 2: External participants at the workshops

Participant	Affiliation	Role / field of expertise
Daniel Hellström	Svenskt vatten	R & D management
Joakim Pramsten	Stockholm water	Urban flooding, water treatment etc.
Magnus Sannebro	Sthlm city env. department	Environment
	Norconsult	Consultant
Lars Marklund	Tyréns	Consultant
Hans Hammarlund	Tyréns	Consultant
Johan Kjellin	Tyréns	Consultant
Daniel Knös	Länsförsäkringar	Insurances
Karin Willis	Stockholm County Administrative Board	Climate adaptation, urban planning
Karin von Sydow	Stockholm County Administrative Board	climate adaptation, urban planning
Ulrika Postgård	Swedish Contingency Agency	senior advisor, natural hazards
Hans Bäckman	The Swedish Water & Wastewater Association	R&D
Maria Tengvard*	City of Stockholm	urban planning
Christina Wikberger*	City of Stockholm	urban planning
Cari Andersson	SMHI	Consultant
Paola Altobelli	Autorità Bacino Reno	General Manager/river basin authority
Paola Angelini	RER - Emilia-Romagna Region Health Direct.	Regional Officer/health/new illnesses
Germana Benassi	COBO – Bologna City Civil protection Dep.	civil protection
Chiara Caranti	COBO - Bologna City Env. Department	Urban environment
Emanuele Cimatti	RER – Emilia-Romagna Region Env. Directorate	Protection of water resources
Marisa Corazza	COBO – Bologna City Env. Department	Urban environment
Giovanni Fini	COBO - Bologna City Env. Department	Manager of the environmental and planning unit of the municipality of Bologna
Marco Folegani	MEEO	Consultant/ project manager
Angelo Giselico	COBO - Bologna City Civil protection Dep.	Head of the Municipal unit for civil protection
Raffaella Gueze	COBO - Bologna City Env. Department	Urban planning/CC adaptation
Fabio Marchi	Consorzio della Chiusa di Casale	River basin authority/Manager
Nicola Mezzadri	NIER Ingegneria	consultant
Paolo Pandolfini	AUSL Bologna – Local Public Health system	Manager of the Epidemiology Unit
Stefania Pasetti	MEEO	consultant
Cristina Ricci	NIER Ingegneria	consultant
Simonetta Tugnoli	RER – Emilia-Romagna Region Env Directorate	Air quality
Paolo Marzaroni	AUSL Bologna – Local Public Health system	Epidemiology Unit/heat waves
Stefano Tibaldi	CMCC – EuroMediterranean Centre for Climate Change	Climate change and CC impacts
Vincenzo Periangeli	AUSL Bologna – Local Public Health system	Epidemiology Unit/heat waves
Elisa Stivanello	AUSL Bologna – Local Public Health system	Epidemiology Unit/heat waves

*Interviewed separately in connection to the workshop

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