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## Memorandum

Signal Group advisory report within the context of the  
six-year review

### Reason for and purpose of this advisory report

- The Delta Programme Signal Group<sup>1</sup> has been set up to alert Delta Programme parties to Delta Programme-wide developments that may have a significant impact on the elaboration and implementation of the Delta Decisions and regional Preferential Strategies.
- The advisory report at hand pertains to several Delta Programme-wide developments that should be taken into account in the first six-year review of the Delta Programme, supplementary to the theme-specific or region-specific developments identified by the Themes and Regions.
- I propose that this advisory report be submitted to the programme managers of the Delta Programme Themes and Regions.

### Background and process

The Delta Programme Signal Group has been set up to alert Delta Programme parties to Delta Programme-wide developments that may have a significant impact on the elaboration and implementation of the Delta Decisions and regional Preferential Strategies, and thus on the dimensioning and scheduling of the measures set out in the Delta Plans. Such developments may pertain to changes in external driving forces, to the impact of such changes on the water system, and to their consequences for the various functional uses. The indicators adopted by the Signal Group to determine the relevance of such developments have been selected on the basis of timeliness, reliability, and relevance. Appendix 1 lists the indicators and the associated primary and supplementary variables (which can provide additional information) employed by the Signal Group. The information required to this end was collected in mid-2018. Once a year, in consultation with representatives of the Delta Programme Themes and Regions, the signals are interpreted in terms of their potential impact on the Delta Decisions and Preferential Strategies.

The first six-year review of the Delta Programme commenced in mid-2018. In the first phase of this review, the Themes and Regions surveyed potential reasons for a revision of the Delta Decisions and regional strategies. These have been incorporated into draft review agendas. At the same time, the Signal Group drew

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<sup>1</sup> The Signal Group is composed of experts from several authoritative knowledge institutes that are of relevance to the Delta Programme: the Royal Netherlands Meteorological Institute (KNMI), the Netherlands Environmental Assessment Agency (PBL), Deltares, Wageningen University & Research Centre (WUR), Rijkswaterstaat-Water, Traffic, and Environment (RWS-WVL), and Statistics Netherlands (CBS).

up the recommendations below regarding Delta Programme-wide developments that should be taken into consideration in this review. On the basis of these recommendations, the Signal Group, at the behest of the Staff of the Delta Programme Commissioner, has subjected the draft review agendas to a “light review”, focused on the identification of any omissions in the developments set out in the respective draft agendas.

**Delta Programme  
Commissioner**  
DC  
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Commissioner

**Date**  
24 October 2018

On 10 October 2018, the Signal Group shared its findings with representatives of the Themes and Regions. The Themes and Regions have fine-tuned their review agendas on the basis of these outcomes. In the weeks ahead, the amended versions will be presented to the Themes and Regions steering groups. The national steering group meeting that will be held on 29 November will address both the review agendas and the Signal Group recommendations at hand. This memorandum contains the Signal Group recommendations regarding the Delta Programme-wide developments that should be taken into account in the first six-year review of the Delta Programme. The Signal Group has applied two criteria in this respect:

- **Strength** of the signal: a strong signal encompasses observations featuring a particular trend which is continued in future forecasts and for which an explanation is available;
- The potential **impact** on the Delta Programme: the impact is significant if the potential trend implies the possibility of circumstances that could extend beyond the Delta Scenarios, and which consequently dictate the accelerated implementation or adaptation/expansion of the existing Preferential Strategies and Delta Decisions.

## Recommendations

The Delta Programme Signal Group has identified the following Delta Programme-wide relevant developments which merit attention in the review, supplementary to the theme-specific or region-specific developments identified by the Themes and Regions:

- **Accelerated rise in sea level:** Along the Dutch coast, the observed rise in sea level is still 2 mm per annum. Since 1995, worldwide measurements have shown an acceleration to approx. 4 mm per annum. Recent scientific publications contain initial indications of a significant acceleration in sea level rise with effect from 2050, caused by the release of Antarctic land ice. As yet, this is still clouded in uncertainty; in the years ahead, the data will be validated in, amongst other things, IPCC reports and new KNMI scenarios (2021). However, the potential impact on the Delta Programme is great.  
*That is why the Signal Group recommends that the review comprise a rough assessment of the potential consequences of the accelerated sea level rise for the current Delta Decisions and Preferential Strategies, and, wherever necessary, an initial survey of the amendments (in terms of schedule, dimensioning, types of interventions) that might be needed. In addition, the Signal Group recommends mapping out the short-term actions that need to be taken in order to enable implementation of such amendments in the long term. Such actions involve both the scope potentially required for such amendments (e.g., for new or larger flood defence systems, sand extraction, or water storage), and the identification of potential short-term spatial developments that could jeopardise such scope. The recommended point of departure is a 1 m, 2 m, and 3 m sea level rise by 2100, looking ahead to 2150.*

- **Extreme Rhine and Meuse river discharges:** extreme Rhine and Meuse river discharges over the past few decades do not show any developments that extend beyond the Delta Scenarios. However, according to an initial analysis of the discharge behaviour of ten rivers in Northwest Europe, the annual maximum discharge volumes have significantly increased, whilst the average summer discharge volumes have decreased. This is indicative of a potential increase in extremely high discharge volumes and a potentially increasing probability of extremely low discharge volumes. The Signal Group recommends that research be commissioned in order to improve the strength of this signal, for example, by an analysis of the aggregate discharge expectations and the frequency of extremes, and for such research to tie in with Rhine and Meuse catchment area-level studies.  
*In anticipation of the outcomes of such further research, the Signal Group recommends more explicit account be taken of extremely low discharge volumes in both the Rhine and the Meuse.*
- **Land use, economic value, and population trends:** the 2015 WLO [Prosperity and Quality of the Living Environment] scenarios provide the most up-to-date forecasts regarding land use and population counts by 2050. At the national level the changes vis-à-vis the Delta Scenarios are not significant, yet at the regional scale level the differences between growth regions and depopulating regions are becoming more pronounced. A case in point is the construction of 1 million new houses in mainly the western and central parts of the country.  
*The Signal Group recommends that the land use and population trends set out in the WLO 2015 scenarios be taken into account in the review of the regional strategies regarding water availability and spatial adaptation, and that an initial sensitivity analysis be conducted of their potential significance in the purview of the first evaluation of the flood protection standards in 2023.*
- **Climatological drought:** as yet, the maximum potential precipitation shortage during the growing season does not show a manifest trend indicative of conditions that extend beyond the Delta Scenarios. However, the Signal Group has identified the following developments:
  - it seems that a trend can be observed pointing to an increasing probability of dry spring seasons;
  - the 2018 summer drought shows the importance of distinguishing between areas that can be fed from the main water system, and the elevated soils and southwest delta that mainly depend on precipitation and groundwater;
  - the irrigated surface area is decreasing (due to a decrease in surface area used for agricultural purposes), yet the irrigable surface area is increasing (more irrigation systems are being constructed). Following several years of drought, this could lead to a sudden, sharp increase in irrigation volumes.*The Signal Group recommends that the above three developments be taken into account in the review of the regional freshwater supply strategies.*
- **Waterlogging:** since 2000, a distinct increase in extreme peak precipitation can be observed, which could possibly continue in the future due to further atmospheric warming. Delta Programme 2018 has already reported on this trend.

*The Signal Group recommends that this year's normative peak intensities of short (2 hour) and long (48 hour) precipitation as published by the Royal Netherlands Meteorological Institute KNMI and the Foundation for Applied Water Research STOWA be taken into account in the stress tests being conducted under the Delta Plan on Spatial Adaptation.*

**Delta Programme  
Commissioner**  
DC  
Staff of the Delta Programme  
Commissioner

**Date**  
24 October 2018

- **Heat stress:** in connection with global warming, maximum three-day summer temperatures in De Bilt (as a measure for temperatures during a heatwave) have been increasing by an average of 0.24 degree Celsius per decade since 1901. Since 1960, this has risen to an average of 0.66 degrees Celsius per decade, i.e., by nearly a factor of 3. The increase may even be more significant in urban areas. Thus, the number of tropical nights is increasing as well.  
*In anticipation of the new KNMI scenarios to be presented in 2021, the Signal Group recommends that this trend of rising temperatures during heatwaves and of an increasing number of tropical nights be taken into account in the stress tests being conducted under the Delta Plan on Spatial Adaptation.*

Supplementary to these signals, the Signal Group recommends that the Themes and Regions be alert to some potential shifts in societal preferences, and to their potential impact on the elaboration and implementation of the Delta Decisions and regional Preferential Strategies, in particular with respect to the choice, design, and implementation of measures:

- a) the increasing importance being attached to an integrated approach. This involves both a stronger interconnection of the three Delta Programme policy fields, and the connection of those policy fields with other policy fields (such as, e.g., water quality, soil subsidence, nature, sustainable energy), and the intensification of the pursuit of potential linkage opportunities contained in the implementation agendas of such other policy fields;
- b) increasing participation of expert and critical residents and stakeholders (--> more attention being paid to plan study and design processes, and within such processes, to natural values and cultural heritage);
- c) increasing uncertainty regarding the bandwidth in sea level rise, involving a greater need for adaptive / short-cycle design.

Yours sincerely,

J.S.L.J. van Alphen  
*Chair, Delta Programme Signal Group*

**Date**  
24 October 2018

Indicator	Variables	Why	Additional variables	Why
<i>Sea level rise</i>	Expected sea level rise along the Dutch coast by 2050, 2100, and 2200	Assumption in the Delta Scenarios, relevant to flood risk management and freshwater supply strategies	Measured and expected worldwide sea level rise (GMSL)	GMSL data features a better signal/noise ratio to identify acceleration in trend
	Annual sand deposit volumes	Effect indicator for sea level rise, impact on coastal strategy	Surface area of Wadden Sea, Oosterschelde, Westerschelde intertidal areas	May require additional measures
	Closure frequencies of Maeslant, Oosterschelde, and Algra storm surge barriers	Effect indicator for sea level rise and storm surges. Relevant to Preferential Strategy for the Rhine Estuary Drechtsteden area.	- Storm frequencies, Northwest >8 Bft - Alarm frequencies for closure of storm surge barriers	- Significant development that affects closure - More frequent alarms give off signal at an earlier stage
	Number of winter days without IJsselmeer discharge capacity	Effect indicator for sea level rise, relevant to Preferential Strategy for freshwater supply	Correction dictated by storm surge and IJssel discharge volume data	
<i>Extreme Rhine and Meuse discharge volumes</i>	Expected extremely high (1:100) and low river discharges (national coordination committee for water distribution LCW limiting values) by 2050 and 2100	Assumption in the scenarios. Significant development that calls for measures; relevant to Preferential Strategies regarding river flood risk management, freshwater supply	- Extremely high and low discharge volumes in 10 rivers in Northwest Europe - Average Rhine/Meuse 6 summer months discharge at Lobith and Eysden - Rhine tributaries discharge distribution and deviation from policy agreement - Upstream developments affecting water supply	- Combined analysis of river discharge volumes enhances possibility of detecting signals - Average values give off signals sooner than do extreme values - Uncertain critical assumption - Such developments affect the inflow of water via rivers

<i>Land use and population</i>	Expected and actual spatial developments, including land use, economic value, population count by 2050 for each COROP region [COROP = Regional Research Programme Coordination Committee]	Assumptions in the scenarios. Relevant to Preferential Strategies because such developments determine protection levels and water requirements. Relevant to security standards for each dyke ring.		
<i>Climatological drought</i>	Precipitation shortages (annual maximum)	Assumptions in the scenarios. Significant development that calls for measures; relevant to Preferential Strategy regarding freshwater supply	<ul style="list-style-type: none"> <li>- Loss of revenue per hectare per crop</li> <li>- Deviation in groundwater levels vis-à-vis desired groundwater situation</li> <li>- Water requirements to be met by main water system</li> <li>- Increase in irrigation units</li> <li>- Failure to attain minimum target level in large lakes (days)</li> </ul>	<ul style="list-style-type: none"> <li>- Climate effect indicator, also affected by land use</li> <li>- Water system effect indicator</li> <li>- Indicator of autonomous adaptation and perception of drought among farmers</li> </ul>
<i>Salinisation</i>	Freshwater supply intake stops (frequency and duration)	Effect indicator for salinisation, relevant to Preferential Strategy regarding freshwater supply	Maximum salt concentration at key intake locations in area south of the major rivers (IJssel estuary, Lek estuary, Bernisse)	Important development in terms of freshwater supply measures, sea level rise effect indicator
<i>Waterlogging</i>	Extreme precipitation (2-hour and 2-day frequency and intensity)	Effect indicator for climate change in urban and rural areas; prompting additional measures. 2-hour data is particularly relevant to urban areas, 2-day data to rural areas.	Damage measurements in combination with damage functions	Assumption in scenarios

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DC  
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24 October 2018

<i>Heat stress</i>	Tropical days (>30 degrees C) and nights (>20 degrees C) (annual number and duration)	Effect indicator for urban areas that may trigger additional measures.	Casualty rates during tropical days/nights	
<i>Knowledge and innovation</i>	E.g., damage functions, cost estimates for measures, strength of flood defence systems	Assumptions in the strategy		

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