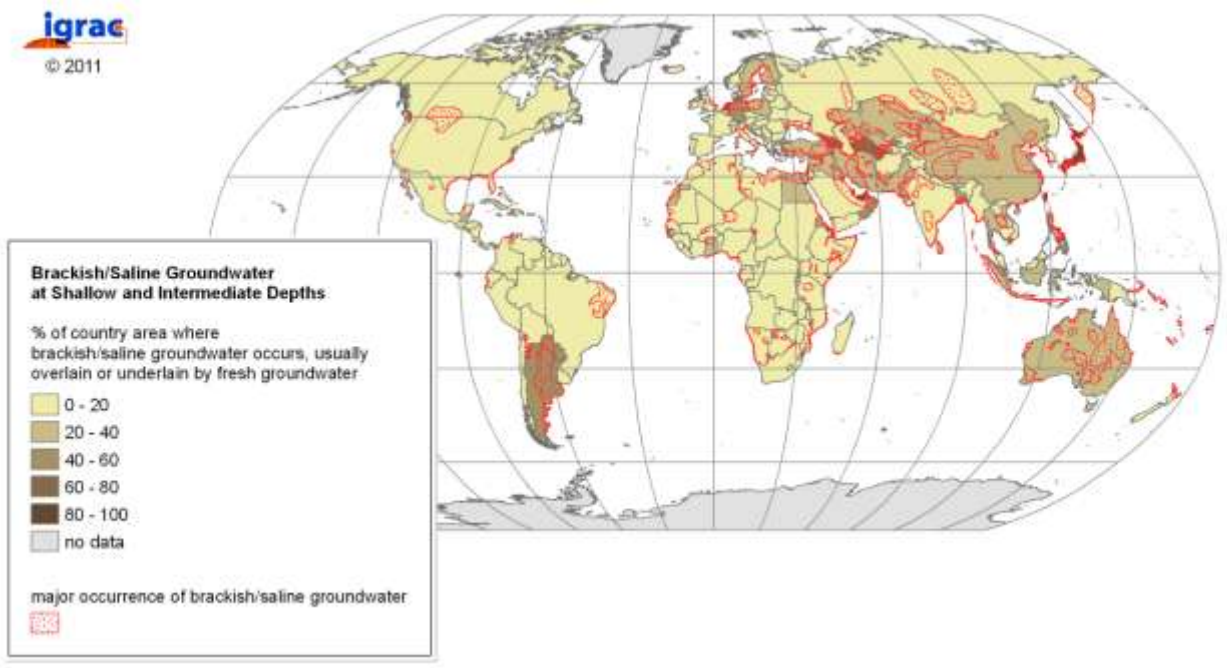
Indicator name	Brackish/Saline Groundwater at Shallow and Intermediate Depths (BSG)



This indicator highlights countries where brackish or saline groundwater is likely to occur at shallow and intermediate depths where it limits, complicates or precludes the use of groundwater for normal domestic, agricultural or industrial purposes. Shades of brown represent % of country area where brackish or saline groundwater occurs. In most cases, in the zones where brackish or saline groundwater occurs it is overlain or underlain by fresh groundwater. For this indicator, groundwater with TDS > 5 g/l is considered to be brackish or saline. The major identified or induced saline groundwater occurrences are presented as red shaded zones on the map. These zones are based on a combination of hard data (like demonstrated groundwater salinity) and proxy information such as the presence of subsurface salt bearing geological layers (Van Weert et al., 2009).

Challenge area	Health; food production; industrial activities; income; ecosystems.
Rationale/relation to the challenge area	The purpose of the indicator is to show where significant volumes of brackish/saline groundwater are known or are likely to be occurring at shallow and intermediate depths. Groundwater at such depths is predominantly fresh; local or regional occurrence of brackish or saline groundwater reduces options for beneficial groundwater use, threatens the quality of surrounding fresh groundwater and may affect groundwater related ecosystems. Information on where brackish and saline groundwater is present or is likely to be present is indispensable for optimal development and management of groundwater resources. 'Shallow and intermediate depths' are meant to coincide with depths that are relevant for conventional groundwater abstraction and that are an 'active' zone within present-day's water cycle. Their lower boundary varies according to local conditions (depending on aquifer properties and on presence/absence of a basal aquitard or aquiclude), and reaches roughly down to 200-500 m below ground surface.
Position in DPSIR chain	State
Definition of indicator	The Brackish/Saline Groundwater Indicator (BSG) for a certain spatial unit is defined as the percentage of the horizontal extent A_t of this unit where brackish or saline groundwater occurs or is likely to occur. If A_{bs} is the area where brackish or saline groundwater may be expected, then: $BSG = A_{bs}/A_t * 100\ \%$
Underlying definitions and concepts	For this indicator, groundwater with TDS > 5 g/l is considered to be brackish or saline. This coincides roughly with the upper limit of mineralization acceptable for irrigating salt tolerant crops. The purpose of the indicator is to show where significant volumes of brackish/saline groundwater are known or are likely to be occurring at shallow and intermediate depths.

	It is based on IGRAC's study that used proxy information and expert judgment to extrapolate an extensive set of documented occurrences of groundwater salinity into larger areas of highly probable groundwater salinity (van Weert et al., 2009). Groundwater at shallow and intermediate depths is predominantly fresh. Shallow and intermediate depths are here meant to coincide with depths that are relevant for conventional groundwater abstraction and that constitute the 'active' subsurface zone within present-day's water cycle. Local or regional occurrences of brackish or saline groundwater reduce options for beneficial groundwater use, threaten the quality of surrounding fresh groundwater and surface water and may affect groundwater related ecosystems. Land and water resources management in the corresponding zones needs to take this high mineralization into account. For example, in the Netherlands more than 80% of the country is underlain by saline or brackish groundwater. In large parts of the country it does not restrict groundwater use, because it is overlain by fresh groundwater down to considerable depth. However, it limits various forms of intensive agricultural production near the coast and puts constraints there on groundwater abstraction locations for drinking water production. Furthermore, it requires large volumes of river water to be allocated to flush the low-lying polder surface waters in order to reduce their salinity partly resulting from seepage of brackish groundwater. Information on where brackish and saline groundwater is present or is likely to be present is indispensable for optimal development and management of groundwater resources. Reference: Van Weert, F., J. van der Gun and J. Reckman (2009). Global overview of saline groundwater occurrence and genesis. IGRAC, Report nr GP-2009-1.
Specification of data & determinants needed	Maps showing demonstrated and/or expected occurrence of saline and brackish groundwater at the depths considered, and at appropriate scale.
Computation	The indicator (BSG) is computed for each spatial unit considered as follows: $BGS = A_{bs}/A_t * 100$ %.
Unit of expression	Expressed in % (dimensionless)
Data sources, availability and quality	For application at global level, a convenient source of aggregated information is a compilation report prepared by IGRAC (Van Weert et al, 2009). It contains references to local and regional sources of information used.
Scale of application	The indicator can be successfully used at the global level, using the 36 global groundwater regions or the 217 groundwater provinces as spatial units (see Van der Gun et al, 2009). Selecting countries as spatial units is possible as well, but may be less effective. For presenting information for a continent or region, the use of a map with the delineated fresh/brackish zones is preferred.
Geographical coverage	The information source mentioned above has world-wide coverage.
Interpretation	The indicator highlights spatial units where brackish or saline groundwater is likely to occur at depths where it precludes, limits or complicates the use of groundwater for normal domestic, agricultural or industrial purposes. Groundwater resources management in the corresponding zones needs to take this high mineralization into account.
Linkage with other indicators	In some zones (e.g. coastal areas) there may be links with groundwater development stress and depletion indicators. More in general, the limitations imposed by groundwater salinity will be reflected in indicators on socio-economic impact of groundwater and on share of groundwater in different categories of water use.
Alternative methods and definitions	-
Related indicator sets	Groundwater development as a share of total actual renewable water resources; Groundwater development stress indicator; Groundwater depletion indicator.
Sources of further information	IGRAC, Avalable on http://www.un-igrac.org (Accessed 06 November 2011) Foster, S., & D. Loucks, (2006). *Non-renewable groundwater resources.* UNESCO-IHP, IHPVI, Series on Groundwater No. 10. Vrba, J., and A. Lipponen (2007). Groundwater resources sustainability indicators. UNESCO IHP-VI, Series on Groundwater No. 14.

	Struckmeier, Wilhem, Andrea Richts, et al, (2008). Groundwater Resources of the World. Final Edition presented at the 33th International Geological Congress, Oslo. Map 1: 25 M, four side-maps 1: 120 M and brief Explanatory Text. BGR Hannover & UNESCO, Paris. Van der Gun, Jac, Slavek Vasak and Josef Reckman (2009). Geography of the World's groundwater: a hierarchical approach to scale-dependent zoning. Submitted chapter for the book *"Sustaining Groundwater Resources"*, edited by J.A.J.Jones, Initiative of the International Year of Planet Earth. Springer, Books on Environmental Sciences. Van Weert, F., J. Van der Gun and J. Reckman (2009). Global overview of saline groundwater occurrence and genesis. IGRAC, Report nr GP-2009-1. Avalable on http://www.igrac.net/dynamics/modules/SFIL0100/view.php?fil_Id=135 (Accessed 06 November 2011).
Involved agencies	IGRAC, UNESCO-IHP, WWAP, WHYMAP