

1 - METHOD BACKGROUND

NAME OR CODE	SYRAH-CE & AURAH-CE - Système Relationnel d'Audit de l'Hydromorphologie des Cours d'Eau & Audit RAPIDE de l'Hydromorphologie des Cours d'Eau
COUNTRY	France
KEY REFERENCE	Chandesris et al. (2008); Valette et al. (2010) http://www.irstea.fr/la-recherche/unites-de-recherche/maly/pole-onema-irstea/hydromorphologie-et-alterations-physiques ; http://www.onema.fr/-Diagnostiquer-les-alterations-
WEBPAGE	
CATEGORY	The aim is to provide an audit system to make an inventory and analyze all hydromorphological alterations/impacts of water courses at the national scale. It is morphological, process-oriented framework

2 - METHOD CHARACTERISTICS

A - SOURCE OF INFORMATION / DATA COLLECTION	Maps/Remote sensing	The method is mainly based on existing maps (e.g. land cover, cartographic, geological, soil erosion maps, etc.) and the uses of GIS techniques
	Field survey	The AURAH-CE protocol collects complementary info (artificial structures) to SYRAH-CE on the field (and permits to validate GIS based analysis of SYRAH)
	Rapid field assessment	AURAH-CE is named to be a "Rapid tool" for the field inventorying of artificial structures (not valid for large rivers)
	Existing database	The method uses existing data from databases (e.g. on human activities on the territory)
	Modelling	NOT APPLICABLE
B - SPATIAL SCALE	HIERARCHICAL SPATIAL SCALE	It uses a multi-scale approach, focusing firstly on catchment spatial processes: it uses a "top-down" approach where large scale damage risk assessment serves to focus analysis of alteration on the lower levels (structure, processes and habitats). Rivers are segmented into homogenous geomorphic reaches, and then into spatial units (USRA). Finally, AURAH-CE is applied at the reach scale, where reaches are randomly selected
	LONGITUDINAL SPATIAL SCALE	NOT APPLICABLE AURAH-CE reaches are long proportionally to channel width
	LATERAL SPATIAL SCALE	It uses homogenous geomorphic reaches within which data are collected at smaller spatial units of data collection and analysis (USRA)
		Channel Banks/Riparian zones Floodplain Land use, activities and artificial structures are collected at the channel, bank and riparian zone, and floodplain scales, on several buffers from the channel: 5 m, 3 times the channel width, and 10 times the channel width, respectively. AURAH-CE collects info mainly on the channel, but also on the banks and riparian area
C - TEMPORAL SCALE	Physical and morphological assessment	It collects data at the present time but collects also evidence of channel evolution
	Hydrological assessment	NOT APPLICABLE
D - TYPE OF METHOD	Characterization/classification	The method serves to developed a national database on hymo structures (impacts) on rivers and streams
	Assessment by index	NOT APPLICABLE
	Deviation from reference	NOT APPLICABLE
	General assessment / Design framework	It uses an environmental risk assessment logic (DPSIR) and an auditing instead of an evaluation protocol; it produces risk maps based on the location and intensity (extent) of artificial structures and the severity of their effect on ecosystem
	Modelling status / Scenario	NOT APPLICABLE
Final expert judgment	NOT APPLICABLE	
Links with other systems	SYRAH-CE and AURAH-CE are distinct protocols which can be combined to get national and local spatial scale information on hymo alteration. SYRAH-CE could represent a database for other systems, such as ROE-ICE and CarHyCE	
E - REFERENCE CONDITIONS		NOT APPLICABLE
F - GENERAL INFORMATION	RIVER TYPOLOGY	Rivers are grouped into homogenous rivers typologies following large scale characteristics (HER, geology, valley features, hydrological network)
	TYPOLOGY LIMITATIONS	NOT APPLICABLE
	TYPE-SPECIFIC (Protocol / Assessment method)	The assessment of physical alteration is done as function of the geographical domain (i.e. mountain vs. plain): for example, bedload sediment deficit (barriers, mining) is not analyzed where slope is low than 4%
	BASIS FOR STANDARDS / THRESHOLDS	NOT APPLICABLE
	REACH SCALE SURVEY STRATEGY	SYRAH-CE records artificial structures at sub-reaches scale (spatial units), at different buffer widths. AURAH-CE collects info by walking along the selected river reach and takes measures at specific points (on the basis of the method adopted)
	TIMING AND FREQUENCY	AURAH-CE needs at mean 1h per reach
	DATA PRESENTATION (OUTPUT/LAYOUT)	Data are presented on map format: risk maps (sediment flux, flow, morphology alteration) as well as density map (of weirs, of embankment, etc.), and high spatial definition maps from AURAH-CE
	METHOD SUPPORT / APPLICATION TOOLS	Several manuals are available: principles and methods of the protocol SYRAH-CE (Chandsresis, 2008), principles and methods for river segmentations (Valette et al., 2008); the Atlas SYRAH-CE (Chandesris, 2009); protocol AURAH-CE (Valette et al., 2010, with field table-sheets to collect field data)
	SPATIAL COMPARISON	The method allows spatial comparison at the national scale
	CONNECTION TO ECOLOGY	It is not direct but the basic assumption is that hymo control variables determine the ecological status of water bodies
USERS	It provides aid for management decision and functional restoration of water bodies. The application of AURAH-CE protocol needs sufficient knowledge in hydromorphology	
SCALE INFORMATION	It provides either large scale info/data (SYRAH-CE) and local scale data (AURAH-CE)	
NUMBER OF END PARAMETERS	SYRAH-CE assesses the risk of flow (3-5 parameters), sediment flux (3 parameters) and morphological (6 parameters) alterations. AURAH-CE analyses/measures pressures (5 parameters) and alterations (4 parameters)	

3. RECORDED FEATURES

	LARGE SCALE CHARACTERISTICS	Info on activities and land cover/use at catchment scale are combined and used to guide the risk assessment at lower levels. Geology (substrate), HER, altitude are used to make the former sectorization of the river in homogenous reaches
A - CATCHMENT / VALLEY	HYDROLOGICAL REGIME	Hydrological conditions Metrics of hydrological regime
	VALLEY FORM / FEATURES	Hydro-peaking It assesses the risk of hydropeaking (globally in the hydro alteration) Valley form and features (width, slope) are used to make the former sectorization of river in homogenous reaches
B - CHANNEL	CHANNEL PATTERN / PLANFORM	River straightening (river tot length/river bird's eye length)
	CHANNEL FORMS	NOT APPLICABLE
	BED CONFIGURATION	AURAH-CE collects and measures bed configuration characteristics (facies, e.g. lentic/lotic conditons, rapid, run, pool, riffle, etc.)
	CHANNEL DIMENSIONS	Examples of measures: Ratio of channel water surface reconstructed/observed; proportion of channel shortened; proportion of channel interested by water intake. AURAH-CE measures bankfull elevation and width
	FLOW-TYPE	NOT APPLICABLE
	PHYSICAL / HYDRAULIC VARIABLES	NOT APPLICABLE
	SUBSTRATE	AURAH-CE collects qualitative information on substrate composition (along riffles) and clogging (qualitative classes)
C - RIVER BANKS/ RIPARIAN ZONE	IN-CHANNEL VEGETATION	NOT APPLICABLE
	WOODY DEBRIS	NOT APPLICABLE
	ARTIFICIAL FEATURES AND STRUCTURES	Dams, weirs, by passed sections, resectioning, bridges, etc. AURAH-CE identifies/measures and characterizes evidences of sediment mining/dredging; it also characterizes (age, general measures, features, etc.) artificial structures (bridge, dam, weir, deflectors, etc.)
	BANK PROFILE / SHAPE	NOT APPLICABLE
	BANK MATERIAL	NOT APPLICABLE
D - FLOODPLAIN	RIPARIAN VEGETATION STRUCTURE	Alteration of riparian vegetation structure/presence (e.g. available surface/river corridor surface)
	LONGITUDINAL CONTINUITY OF RIPARIAN VEGETATION	Lack of riparian forest
	RIPARIAN VEGETATION WIDTH	NOT APPLICABLE
	VEGETATION COMPOSITION, COVERAGE AND OTHER RIPARIAN VEGETATION CHARACTERISTICS	NOT APPLICABLE
	ARTIFICIAL FEATURES AND STRUCTURES	Riparian zone artificialization, embankment, resectioning, dikes, stabilisation, channelization, levees, etc. AURAH-CE characterizes (material, age, orientation, distance from channel, etc.) and measures embankments, as well as bank protections
	LAND USE	Intensive farming, gravel mining, roads, plantations, etc.
	FLUVIAL FORMS	Water bodies
	INFO ON FLOODPLAIN FEATURES	NOT APPLICABLE
	LAND USE	

4. RIVER PROCESSES

A - LONGITUDINAL CONTINUITY	Sediment and wood	The method gives a risk of sediment fluxes alteration in terms, (e.g. in terms of bed load retention)
	Water flow	The method gives a risk of flow regime alteration in terms of barrier structures and water storage (dam, weirs), as well as in terms of drainage network for irrigation. The alteration could interest e.g. flow regime, flow modification, hydropeaking, low flow frequency, etc.
B - LATERAL CONTINUITY	Lateral hydraulic continuity	Through the risk of flow regime alteration in terms of barrier structures (alteration of flood frequency and intensity)
	Sediment (and wood) lateral continuity	It assesses the risk of alteration of soil erosion due to land use at large scale
C - BANK EROSION / STABILITY		It assesses the lack of lateral dynamic because of bank protection structures
E - CHANNEL ADJUSTMENTS	Planimetric (pattern & width)	The method assesses the risk of alteration of channel morphology (lateral and vertical) by the presence of structures such as weirs, channelization, embankments, bank protection, etc. AURAH-CE collects info on vertical incision (qualitative indices, e.g.: erosion at bridge basis, substrate outcropping, etc.)
	Vertical	The method assesses the risk of alteration of channel morphology (lateral and vertical) by the presence of structures such as weirs, channelization, embankments, bank protection, etc. AURAH-CE collects info on vertical bed adjustment (qualitative indices, e.g. erosion at bridge basis, substrate outcropping, etc.)
F - VERTICAL CONTINUITY	Groundwater connection	Water abstraction for irrigation is assessed in terms of risk of alteration of the flow regime

5. APPLICATION TO WFD

OFFICIAL METHOD (WFD implementation) / COMMONLY USED METHOD (not compulsory)	The method has been developed by the Cemagref (now IRSTEA) & Onema since 2006, under the request of the French Ministry of the Ecology and of the Sustainable Development to comply to WFD requirements.
APPLICATION TO ALL WATER BODIES USED IN THE CLASSIFICATION OF HIGH-STATUS / OTHER STATUS CLASSES	It has been applied to all the French metropolitan territory
USED TO PREDICT RISK OF DETERIORATION	It can support the definition of several states (such as reference conditions)
USED TO IDENTIFY IMPROVEMENT TARGETS	It can be used for this purpose given that it maps/identifies risk zones in terms of sediment fluxes, flow regime and morphology alteration
USED TO HELP IDENTIFY CAUSE OF ECOLOGICAL IMPACTS	Info collected by the method can be combined with data required for management, programming, decision-making and assessment of restoration actions
KEY STRENGTHS FOR RIVER MANAGEMENT	The method has identified 14 types of hydrological damage which are most likely to be the cause if impact in ecological state of watercourses It is an open/adaptive system and at a national scale