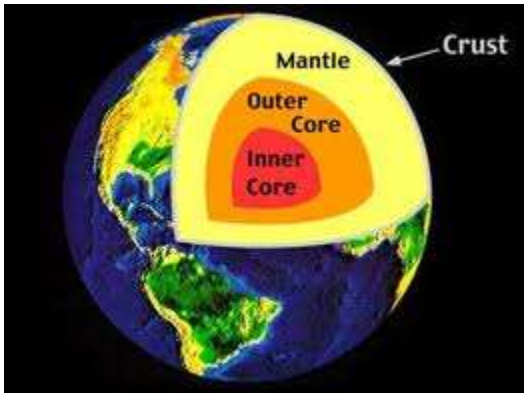
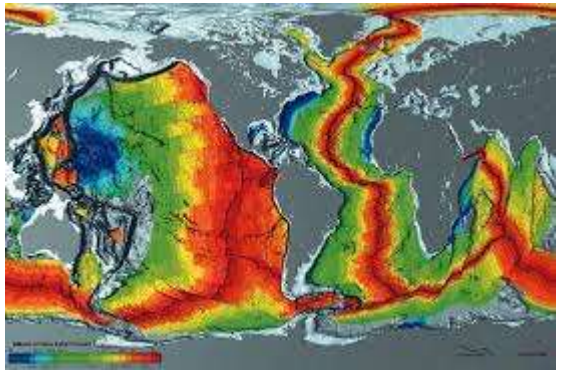
EARTH SYSTEM

: INTRODUCTION





Dr. Vivek S. Kale

ACWADAM

PUNE.

A VIEW OF THE EARTH FROM SPACE


A VIEW
OF THE
EARTH
FROM
WATER

A VIEW OF THE EARTH FROM LAND

WHAT IS COMMON

IN ALL THESE PICTURES / VIEWS ?

NATURAL BEAUTY ……..

Of course … unparalleled !

VISUAL DELIGHT …….

Undoubted !

….. ….. …. AND SOMETHING ELSE,
WHICH WE ALL TAKE FOR GRANTED AND ASSUME AS

.. ..

"SURE, I KNOW …. So what ?"

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AIR
LAND
WATER


AIR
LAND
WATER


AIR
LAND
LIFE
WATER

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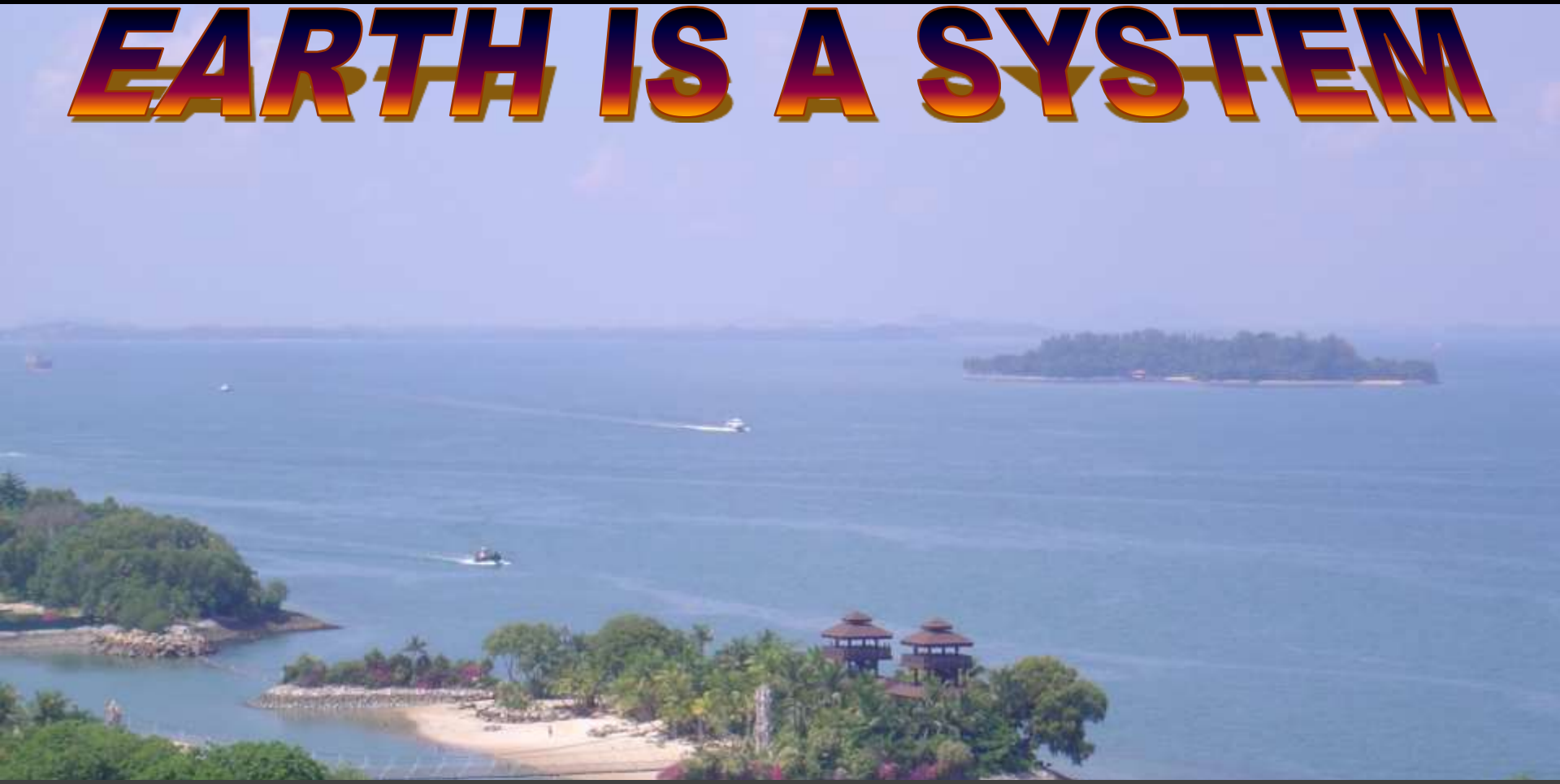
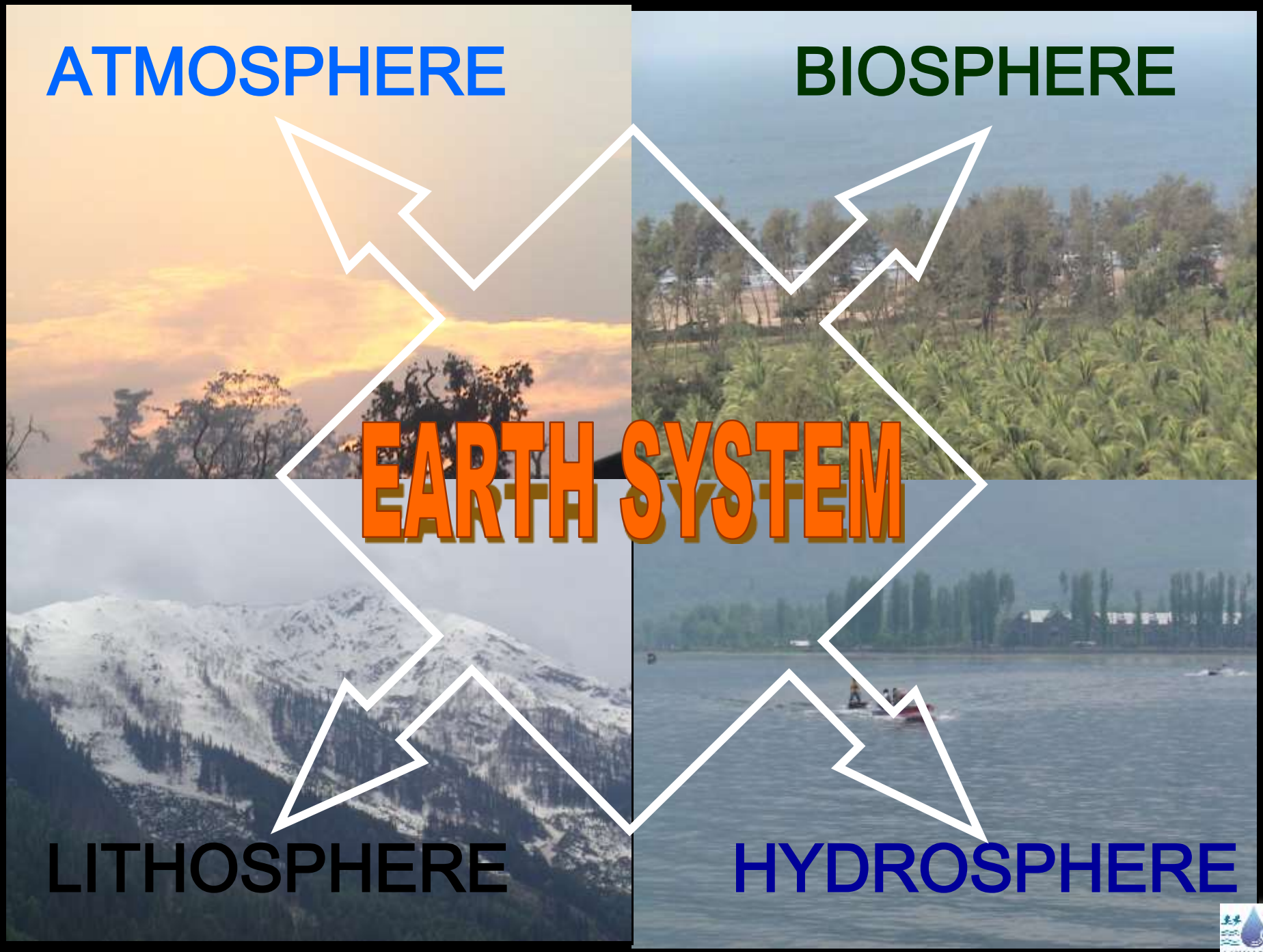
EARTH IS A SYSTEM



THE FOUR "*ELEMENTS*" THAT MAKE UP THIS SYSTEM:

- LAND- LITHOSPHERE
- WATER- HYDROSPHERE
- AIR- ATMOSPHERE
- LIFE- BIOSPHERE


ATMOSPHERE
BIOSPHERE
EARTH SYSTEM
LITHOSPHERE
HYDROSPHERE

Besides displaying the 4 ‘elements’ that make up the Earth System, do these pictures not show us something else?

Besides displaying the 4 ‘elements’ that make up the Earth System, do these pictures not show us something else?

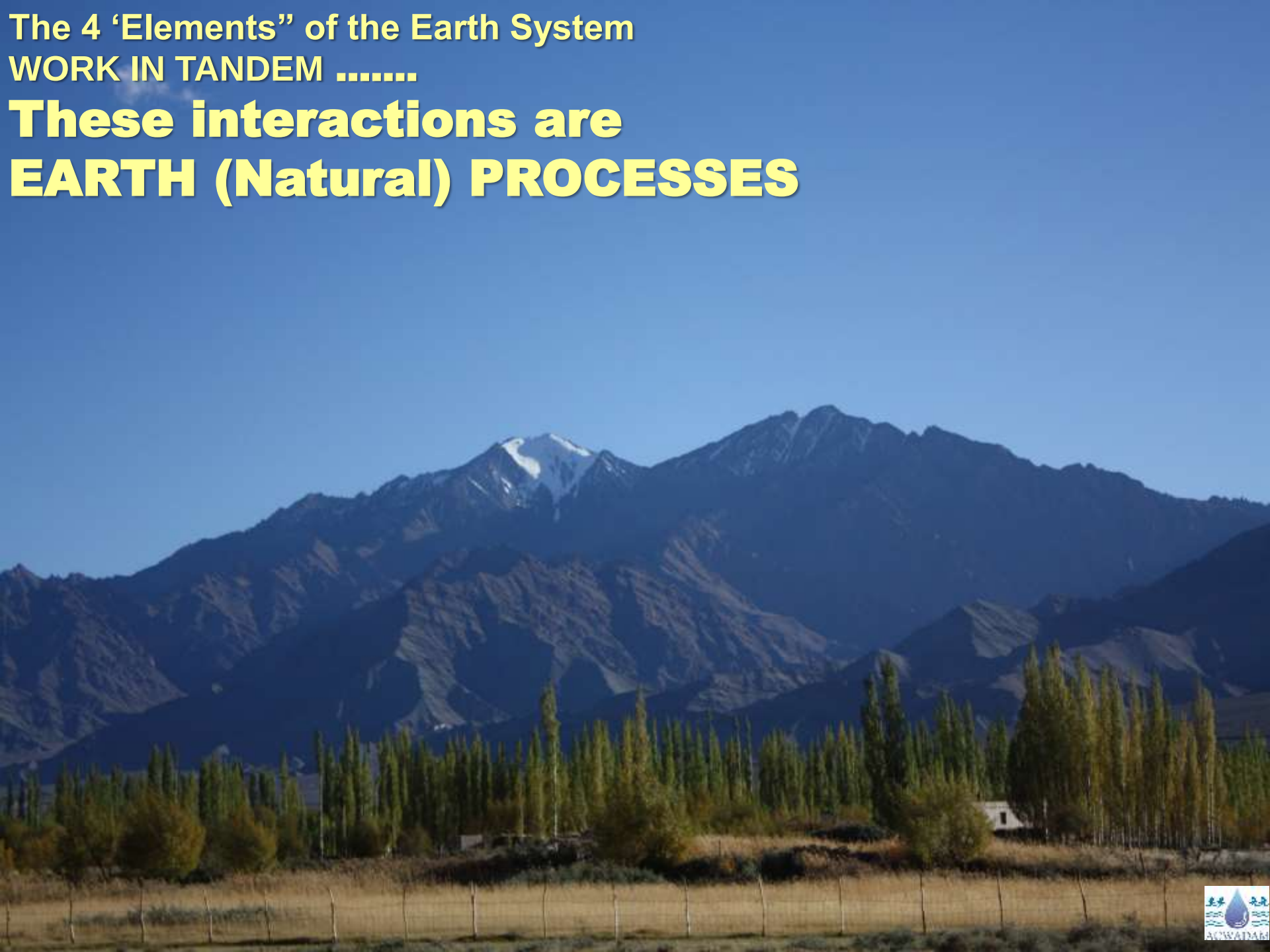
The Earth System, Is DYNAMIC Not Static!!

Everything CHANGES
Nothing is PERMANENT!


The 4 ‘Elements” of the Earth System
WORK IN TANDEM
CREATING A
RESOURCES POOL
THAT …. …….


WE ARE
EXPLOITING

Or ……
Utilizing to satisfy our basic needs……..
Of Survival !!!


The 4 ‘Elements” of the Earth System
WORK IN TANDEM .....
These interactions are
EARTH (Natural) PROCESSES

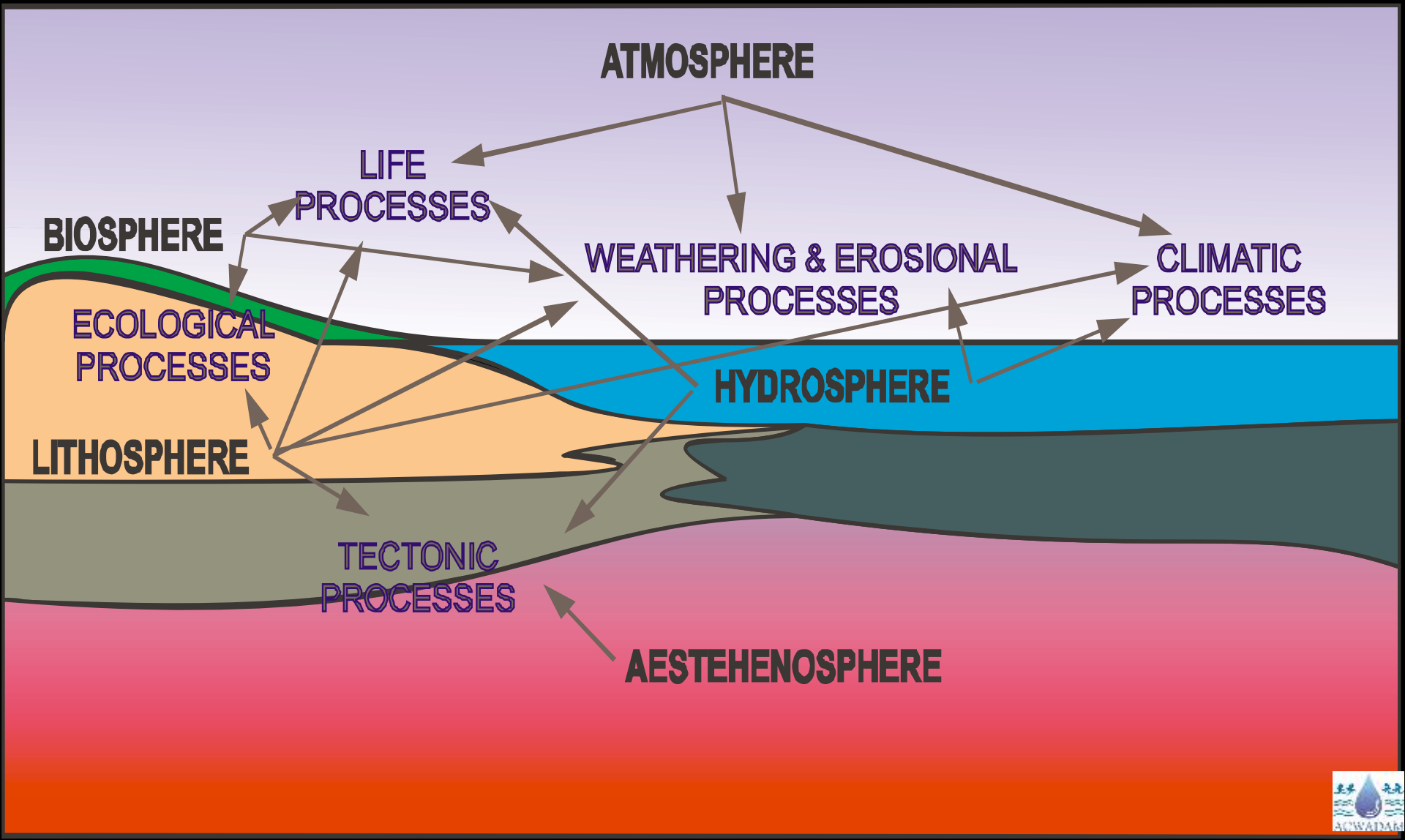
THE LANDSCAPE

IS THE RESULT OF THESE PROCESSES ACTING

FOR THOUSANDS OF MILLIONS OF YEARS.


And will continue to act for the next
hundreds of millions of years

INTERRELATIONS BETWEEN EARTH'S SPHERES & PROCESSES



EARTH PROCESSES

INVOLVE INTERACTIONS BETWEEN

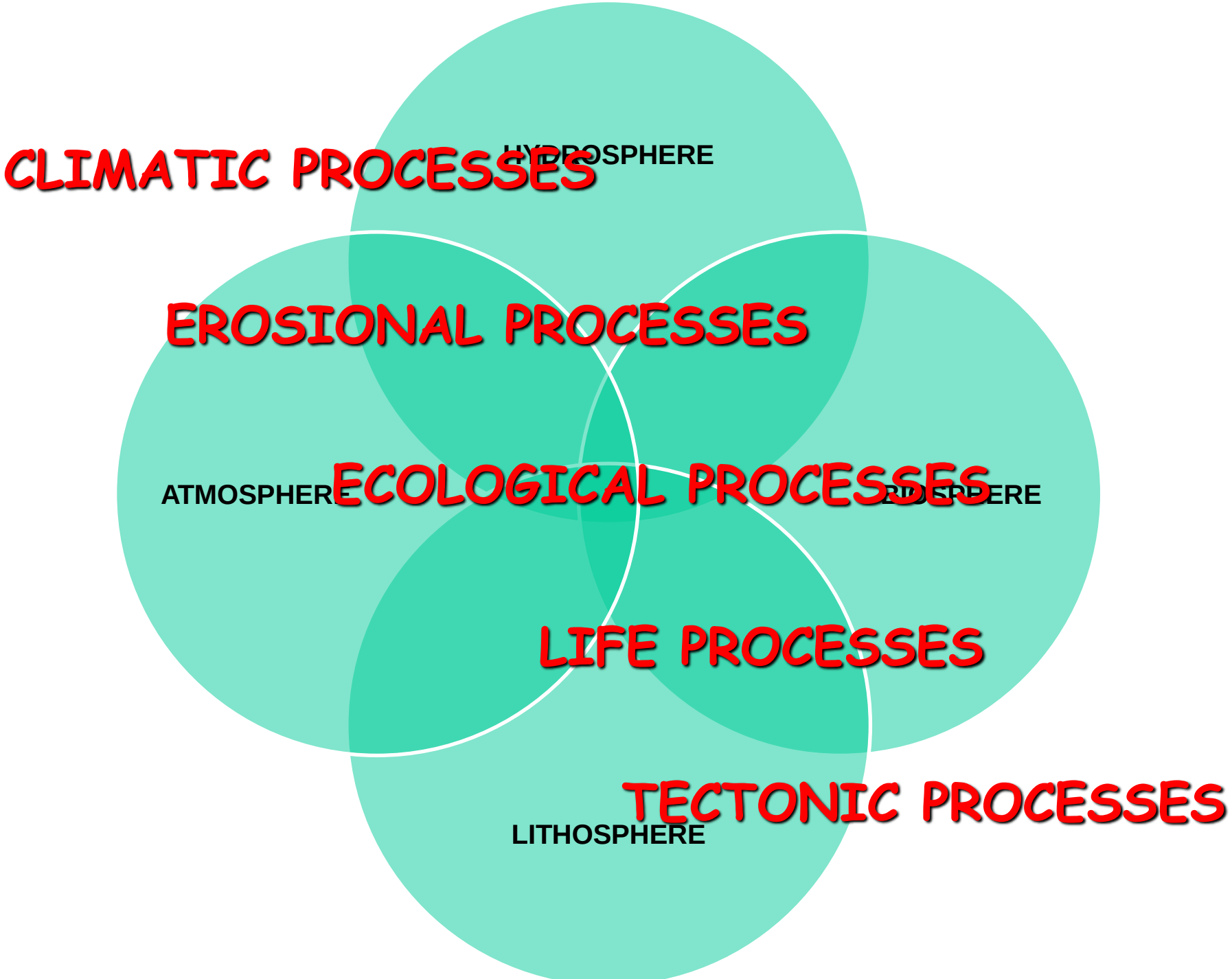
- LITHOSPHERE [LAND]
- HYDROSPHERE [WATER]
- ATMOSPHERE [AIR] &
- BIOSPHERE [LIFE]

EACH HAS ITS OWN RULES AND INTRICACIES

& DISPLAY VARIATIONS WITH THE PASSAGE OF

T I M E

BOTH IN CONTENTS AND FORM … … …


CLIMATIC PROCESSES
HYDROSPHERE
EROSIONAL PROCESSES
ATMOSPHERE
ECOLOGICAL PROCESSES
BIOSPHERE
LIFE PROCESSES
TECTONIC PROCESSES
LITHOSPHERE

CLIMATIC PROCESSES

OPERATE IN	ATMOSPHERE
PERIODICITY	FUNDAMENTALLY CYCLIC
TIME FRAME	HOURLY, DAILY, MONTHLY, ANNUALLY, LONG-TERM.
PRODUCTS	WEATHER CONDITIONS; STORMS, ….

EROSIONAL PROCESSES

OPERATE IN	LITHOSPHERE
PERIODICITY	CONITINUOUS
TIME FRAME	SECOND BY SECOND
PRODUCTS	WEATHERING OF ROCK MASS; LANDFORMS

ECOLOGICAL PROCESSES

OPERATE IN	BIOSPHERE & LITHOSPHERE
PERIODICITY	ACTION IS CONTINUOUS, BUT EFFECTS ARE LONG-TERM
TIME FRAME	DECADES, CENTURIES
PRODUCTS	ECOSYTEMS; ENVIRONMENTAL BALANCES

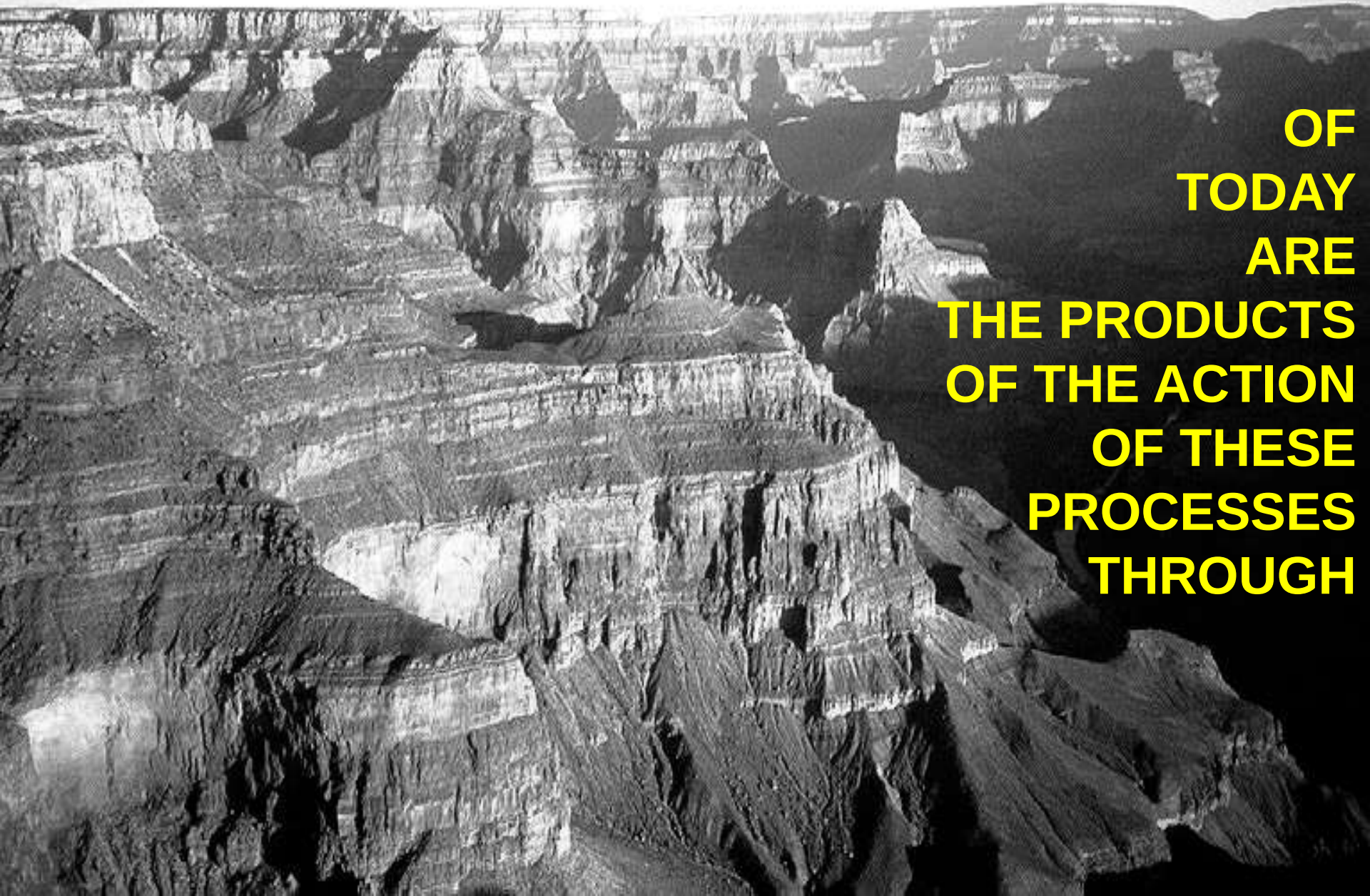
LIFE PROCESSES

OPERATE IN	BIOSPHERE
PERIODICITY	EVOLUTIONARY
TIME FRAME	CONTINUOUS
PRODUCTS	LIFE FORMS

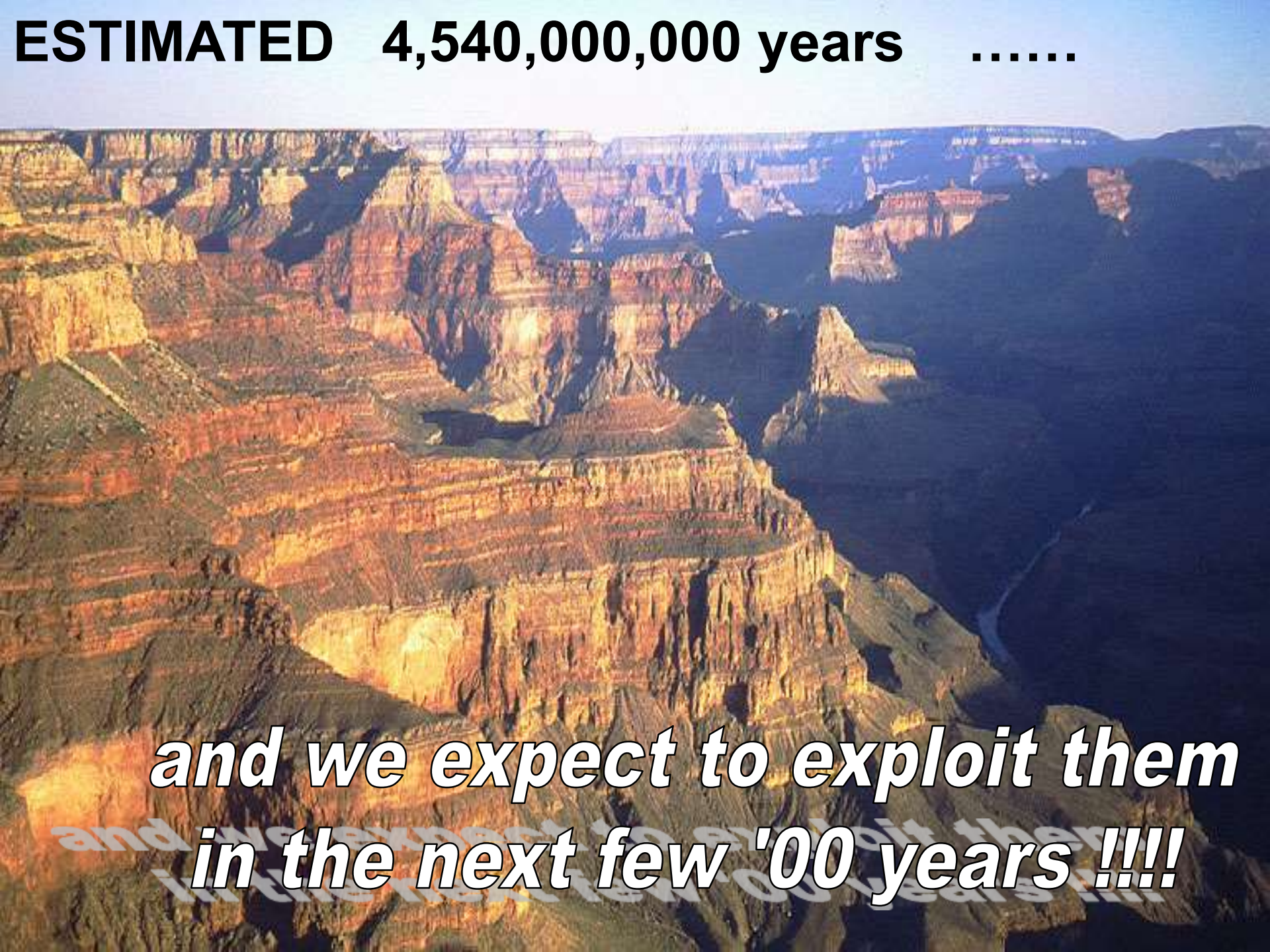
TECTONIC PROCESSES

OPERATE IN	LITHOSPHERE
PERIODICITY	RHYTHMIC
TIME FRAME	GEOLOGICAL TIME SCALE
PRODUCTS	CONTINENTS AND OCEANS, LANDSCAPES

THE LANDSCAPE & RESOURCES



ESTIMATED 4,540,000,000 years ……



Geological Rhythms ……

# I	ROCK UNIT	# II	TIME UNIT	PERIODICITY	PROABABLE CAUSE	GENETIC MEANING	AERIAL DISTRIBUTION
1st Order	**Mega-sequence set**		**Megacycle set**	[~ 350±100] x 10^6 years	Period-doubling of the coupling effect between mantle convection and lithospheric tectonics.	Stratigraphic record of global tectonic cycles (= ? Super-continental cycles) recognisable on a global scale.	Global recognition, covering contiguous terrains.
1st Order	**Mega-sequence**		**Megacycle**	[~ 180±50] x 10^6 years	Ocean expansion and contraction caused by cyclic coupling between mantle convection and lithospheric tectonics.	Stratigraphic record of lithospheric extension and compression (= Wilson cycle or equivalent tectonism).	Regional, within specific terrains which form a continuum of depositional basins. May have extra-terrain correlativity.
2nd Order	**Super-sequence** (Primary & Secondary)		**Super-cycle** (Primary & Secondary)	[~ 45 ± 5 & ~ 22 ± 5] x 10^6 years	Pulses of ridge-spreading and phases of ocean basin expansion and contraction.	Compendium of sequences that define depositional basins and their tectonic stages.	Regional, within a single geotectonic terrain.
3rd Order	**Sequence**	**8th**	**Major Global Eustatic Cycles**	[1 *to* 11] x 10^6 years	Coupling between intraplate stresses, basin-scale tectonics and spreading-ridge pulses.	Basin filling rhythms defined by set(s) of parasequences, bed-sets and beds.	Singular depositional basin.
4th Order	**System-tract**	**7th**	**Minor Eustatic Cycle / Subcycle**	[0.1 *to* 1.0] x 10^6 years	Variations in the sediment distribution potential in response to the basin geometry & sediment influx into the basin. Milankovitch-band cycles may influence.	Depositional systems with their inherent sedimentological characters, such as deltaic complex; submarine fans, shore-line deposites, etc.	Selective sectors within a depositional basin.

Geological Rhythms ……

# I	ROCK UNIT	# II	TIME UNIT	PERIODICITY	PROABABLE CAUSE	GENETIC MEANING	AERIAL DISTRIBUTION
5th Order	**Depos-itional Facies**	**6th**	**Eustatic Subcycle**	10^4 *to* 10^5 years	Hydrodynamic or chemical interactions between the depositional environments and the transporting system, under the influence of Milankovitch cycles.	Sedimentological facies defined by a specific set of hydrodynamic conditions, depositional interface, depositional medium, their characters and the environments; such as intertidal midflats, beach, major sand-lobes, ergs, etc.	Mappable dimensions on normal scale of geological mapping.
6th Order	**Subfacies & sets of syngenetic beds**	**5th**	**Eustatic Subcycle**	10^3 *to* 10^4 years	Long term geomorphic processes which persist over 'ka' magnitude durations and are generally not punctuated by tectonic breaks.	Channelled; lensoid; lobate bodies of similar sediments having a nearly identical depositional history; such as delta lobes, sand ridges, tidal channels, etc.	Mappable dimensions on normal scale of geological mapping.
7th Order	**Macroform deposits**	**4th & 3rd**		10^0 *to* 10^3 years	Episodic and catastrophic variations in the depositional systems which may or may not be brought about by tectonic events (like seismicity).	Deposits created in direct response to seasonal or epiosodic flood or storm; such as sand waves, point bars, eolian dunes; hummcky cross-stratied beds, etc.	Generally not mappable dimensions on normal scale of geological mapping, but may be mapped in high resolution work and in lithologs.
8th Order	**Mesoform deposits**	**2nd**	**Neap - spring / Annual tidal cycles**	10^{-2} *to* 10^0 years	Annual / Neap - spring tidal cycles; and equivalent processes operating exclusives in the hydrodynamic regime of the depositing medium.	Individual Beds or couplets; such as tidal rhythmites, tidal bundles, beach dunes, etc	Not mappable but can be recorded in lithologs.
9th Order	**Mesoform deposits**	**1st**	**Diurnal and daily tidal cycles**	10^{-3} *to* 10^{-5} years	Processes operating exclusives in the hydrodynamic regime of the depositing medium in short durations of minutes and hours, like the daily or diurnal tidal cycles.	Individual Layers or stratal laminations which are controlled in their geometry by the operating process; such as ripples, tidal bundles, reactivations surfaces, etc.	Can be recorded in only in high resolution lithologs and within stratal pattern discriptions.

THE STUDY OF EARTH

= GEOLOGY

INVOLVES THE UNDERSTANDING OF THE CONSTITUENT ELEMENTS, THE PROCESSES AND THE RESULTS OF THESE PROCESSES.

RESOURCES EVALUATION,
PROCESS IMPACTS

RESOURCE MANAGEMENT

Studies which start from

- Satellite data,
- Field data collection,
- Laboratory studies,
- Sophisticated instrumented studies, …

And end up with

- Compilation and analysis

Are unavoidable, if we are to … …

Draw meaningful conclusions and Create realistic plans.

Disregard of OR lack of appropriate appreciation /

understanding of the

“Elements” and “Processes” of the Earth System

Disregard of OR lack of appropriate appreciation /

understanding of the

“Elements” and “Processes” of the Earth System

can (*and in the past has time and again*)

lead to ….. …..


= VIRTUAL REALITY

A holistic view of the Earth System
and appreciation of diverse perspectives helps us

understand dynamics,
assess and plan
resource utilisation
more efficiently and sustainably.